THE GLASS INDUSTRY

VOLUME 24, NUMBER 4, APRIL, 1943

BERYLLIUM IN GLASS*

By KUAN-HAN SUN
Eastman Kodak Company, Rochester, N. Y.

PART I

Although beryllium was one of the 28 elements introduced into glass batches by Schott,[34] the chemistry of beryllium-containing glass has become significant only in the last 15 years. To date, there have been only seven systematic studies, known to the writer, on glasses containing beryllium. Further investigations are needed before the role of beryllium in glass can be thoroughly understood.

The study of beryllium in glass is both of commercial importance and of theoretical interest. In general, beryllium contributes to glass low thermal expansion, hardness, high stability, transmission of ultraviolet and x-rays, and other desirable properties. Beryllium fluoride is the only simple fluoride known to form a glass. Beryllium oxide is one of the two oxides known to glass technologists as "intermediate oxides," the other being aluminum oxide.

This review is intended to summarize the chemistry of all kinds of glass containing beryllium. No attempt is made to discuss the chemistry of raw materials, as this information is readily accessible elsewhere in standard reference books.[21] A recent review on beryllium oxide by White and Shremp[86, 87], however, may be mentioned.

THEORETICAL DISCUSSION

Beryllium is an element of very low atomic number (four). It forms ions (Be^{++}) having a small ionic radius (0.31 A, after Pauling[60]). Because of the low atomic number of beryllium, glasses containing it have lower absorption coefficients for x-rays than otherwise comparable glasses not containing this element. Beryllium oxide as a glass constituent usually contributes both stability and strength, a fact attributable to the tendency of each beryllium atom to form strong bonds to four surrounding electronegative atoms—usually oxygen. These bonds are intermediate in character between pure electron-pair bonds and ionic "bonds." In so far as they are ionic, their strength is attributable to the small ionic radius of Be^{++}, together with its not-too-small charge.

Beryllium Oxide as an Intermediate Oxide

The terms *glass-former* or *network-former*, *intermediate oxide*, and *modifier* are commonly used in the current literature. These terms will now be explained.

If one melts down the oxides (or other compounds) of all the elements in the periodic table and quenches them as rapidly as laboratory technique will permit, one obtains either a glass or a crystalline material. (It is not justifiable to call a substance "glass" just because it appears glassy or isotropic. One of the most conclusive ways of identifying a glass is by x-ray diffraction methods, which yield broad diffuse bands for glasses, but sharp rings for crystals.) Of all the oxides, only a limited number of oxides are known to form glasses, capable of existence at room temperature over long periods of time. These are B_2O_3, SiO_2, GeO_2, ZrO_2, P_2O_5, V_2O_5, As_2O_5, As_2O_3, Bi_2O_3 and possibly P_2O_3, As_2O_4 and Sh_2O_5.** They are called the *glass-formers*.

Glasses of many different compositions can be produced by melting one or more of the glass-forming oxides with other oxides, the latter being present in amounts such that the ratio of the total number of oxygen atoms to the total number of atoms of the (more) metallic elements in the glass-forming oxides does not exceed four.† The glass-formers may be considered as producing a backbone or network structure in these compound glasses; they are therefore also called *network-formers*. Oxides such as Li_2O, Na_2O, CaO, BaO, etc., which do not by themselves form glasses, but which can be glass constituents (along with glass-formers), are called *modifiers*.

Oxides, such as Al_2O_3, which do not form glasses by themselves but act in one way or another as network-formers in compound glasses are called *intermediate oxides*. Under suitable conditions, such oxides may form glasses with modifiers without any of the usual glass-formers. Glasses of the compositions: $12CaO \cdot 7Al_2O_3$, $5CaO \cdot Al_2O_3$, and $MgO \cdot Al_2O_3$ have been reported by Buessem and Eitel[10], Akiyama and Sawayama[1], and Gaubert[19], respectively. Al_2O_3 was the only intermediate oxide recognized before Sun and Silverman[74] added BeO to this class. These authors showed that all the glass-formers and intermediate oxides have a value of ρ, de-

*Communication No. 913 from the Kodak Research Laboratories, Rochester, N. Y.

**Hägg[29] failed to prepare V_2O_5 glass though Morey[86] included this oxide among those giving glasses. In contradiction to Zachariasen[99] and Morey[85], it is now generally accepted that pure Ta_2O_5 will not form a glass. The existence of Cb_2O_5 in the vitreous state is also very doubtful. Cohn[14, 15] reported that ZrO_2 forms a glass. Randall and Rooksby[62] made Bi_2O_3-glass in connection with their x-ray study of glass structure. Many investigators have tried to prepare Al_2O_3-glass by various means but none has succeeded.

†A few glasses are shown in which the ratio is greater than four, as pointed out by Sun and Silverman.[73]

fined as the ratio of the cation radius to the oxygen (or anion) radius, smaller than 0.414. The ρ values for beryllium oxide and fluoride are both below 0.414. Other theoretical considerations and studies of the behavior of beryllium oxide in glasses also show that BeO is definitely an intermediate oxide.

The role of beryllium in the field of non-oxide glasses is unique. BeF_2 is the only fluoride known to be a glass-former. The structure of BeF_2 glass has been worked out by Warren and Hill[81], who obtained good agreement with their experimental results by assuming a continuous random network structure, with each beryllium atom surrounded by four fluorines and each fluorine, in turn, by two berylliums, a structure similar to that of vitreous SiO_2. The low electrical conductivity of molten BeF_2 has led Hägg[20] to the probably erroneous conclusion that BeF_2 is not as ionic in nature as BeO and that their properties with respect to glass formation are different. From Pauling's electronegativity scale[60], Be-F bonds should be even more ionic in nature than Be-O bonds.

SILICATE GLASSES

BeO-SiO_2 System

There has been no systematic study of this system. Greig[26] mentioned that a composition of 5 weight per cent BeO and 95 weight per cent SiO_2 (11.2 and 88.8 mole per cent, respectively) forms a clear glass. Machatschki[50] found that rapid cooling of molten phenacite, Be_2SiO_4 (45.4 weight per cent BeO), produced an opal-like mass which contained BeO-crystals and a BeO-SiO_2 glass of unidentified composition. As in many binary systems, there is apparently only a limited range of composition in this system in which a glass may be formed.

BeO-Al_2O_3-SiO_2 System

There has been no systematic study of this system, either. Devers[16] obtained vitreous materials by fusing in the electric furnace compositions containing between 1 and 10 weight per cent beryl, $3BeO \cdot Al_2O_3 \cdot 6SiO_2$, the rest being quartz. The products were used for electrical insulators.

BeO-Na_2O-SiO_2 System

Glasses of this system have been studied most thoroughly. Lai and Silverman[44] were the first to investigate them. They have shown that within a certain area in the ternary composition diagram clear glasses can be made, at temperatures of 1400-1430°C. Owing to its low formula weight (25.02) and high melting point (2520°C.[82]), the weight percentage of BeO which can be present in a glass of this system is relatively small. The glass with the highest BeO content in Lai and Silverman's diagram has the approximate composition: 18, 32, and 50 weight per cent (34.8, 24.9 and 40.3 mole per cent) of BeO, Na_2O, and SiO_2, respectively. It is clear that molecularly the amount of BeO which can be introduced is by no means small. Lai and Silverman reported density, refractive index,* and hardness values for 16 glasses having the general molecular formulas: $xBeO.Na_2O.ySiO_2$, where x has values 0.50, 0.75, 1.00 and 1.25 and y the values 3.50, 3.75, 4.00 and 4.25. Increase of BeO in each series of fixed Na_2O:SiO_2 ratio, increases the density and refractive index, but affects the hardness but little. The densities of the glasses containing BeO are lower than those of the MgO and CaO glasses of corresponding molecular compositions. Glasses containing BeO are much harder than the corresponding MgO and CaO glasses. The refractive indices of these three classes of glasses increase in the order MgO, BeO, CaO. In a qualitative study of ultraviolet transmission, Lai and Silverman found that BeO-containing glasses have transmissions which are higher than those of the corresponding CaO-containing glasses but lower than those of the corresponding MgO-glasses. The transmission decreases as the BeO content increases in these glasses.

Rencker[63, 64] reported the linear coefficient of thermal expansion and "transformation temperature" of 15 BeO-Na_2O-SiO_2 glasses in which the highest BeO content was 14 weight per cent. He found that the replacement, on the weight percentage basis, of either SiO_2 or Na_2O by BeO caused an increase in "transformation temperature." Replacing Na_2O by BeO lowered the coefficient of expansion, but replacing SiO_2 by BeO produced no appreciable change.

Becker[5] investigated 16 glasses with the general molecular compositions: (A) $xBeO \cdot Na_2O \cdot SiO_2$, where x varied from 0.2 to 1.8, and (P) $xBeO \cdot (1\text{-}x)\ Na_2O \cdot 3SiO_2$, where x varied from 0.1 to 0.4. A few glasses containing MgO, CaO, and Al_2O_3 of corresponding composition were also made. In the (A) series, increase of BeO content caused increases of density, scratch hardness, "transformation" temperature, annealing temperature, and refractive indices for the C, D, and F lines, but decreases of light transmission, coefficient of thermal expansion, and chemical solubility. In the (P) series, the molecular substitution of Na_2O by BeO produced (a) an increase of scratch hardness, "transformation" temperature, annealing temperature, and refractive indices for the lines C, D, and F, (b) a decrease of chemical solubility, coefficient of thermal expansion, and light transmission, and (c) almost no change in density. Becker's results and those of Lai and Silverman are in agreement.

Gotteried[25] measured mass absorption coefficients, for soft X-rays (MoKα of Becker's glasses. Increase of BeO in series (A) decreased the mass absorption coefficients. The substitution of Na_2O by BeO in the (P) series produced little change in the coefficients. The coefficients were about the same for BeO, MgO, and Al_2O_3 glasses but much higher for the CaO glasses of similar molecular compositions.

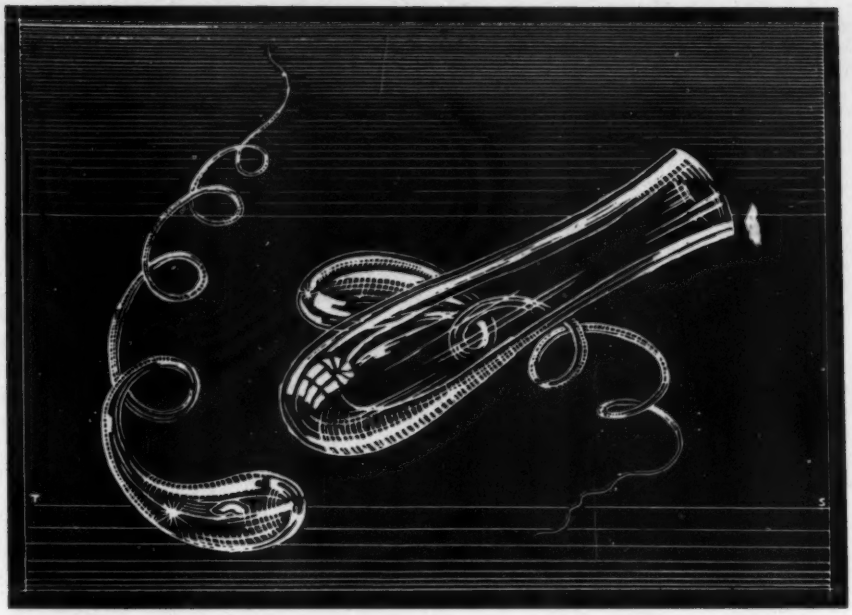
All the data just discussed are abstracted in Morey's well-known monograph, "The Properties of Glass." It may be noted, however, that Morey's values for Rencker's data were not taken from the original reference[64], but from an abstract in the Journal of the Society of Glass Technology, in which the data were only presented graphically.

A comparison (Table I) of the properties of BeO-containing glasses with those of corresponding glasses containing MgO, CaO and Al_2O_3 shows the particular effect of the presence of the BeO. A glass containing BeO or Al_2O_3 is more rigidly bonded than the corre-

*The refractive index data reported were corrected in a later paper [5]

(*Continued on page* 172)

Glasshouse Friggers



Prince Rupert's Drops and the Bologna Phial

by T. Taylor Seago

Editor's Note: The term "frigger" as used in English glasshouse parlance embraces all objects made from glass during spare moments by the glassworkers around the furnace. Mr. Seago, the author, has submitted a series of articles on these unique glass objects to The Glass Industry for reprinting in the belief that in such times as these, and despite the highly mechanized methods which have been developed, it is necessary to keep alive an appreciation of the craftsmanship which is inherent in the workers of the glass industry both in Britain and the United States. As Mr. Seago, a practical glassman of many years' experience and Crowther Prizeman for three consecutive years under Professor W. E. S. Turner of Sheffield University, states "glasshouse friggers are worthy of note sometimes because of their antiquity and peculiarities, often for their beauty, and always for the manner in which they express the inventiveness of the worker, showing, as they do, his intense interest in his craft."

Prince Rupert's Drops are strange tadpole-like glass objects, with long curly filamentous tails; they have been famous for some centuries.

These curious "friggers" owe their name to the fact that they were introduced into England, from the Continent, by Prince Rupert of Bavaria, Elector Palatine and grandson of James I of England, about the middle of the 17th century. He brought them to the notice of the King and exhibited some to his Association in Gresham College.

These drops are made by allowing small globules of very hot molten glass to fall into a vessel of water, preferably warm. The glass falls in the form of a tear or elongated globule and its long tail curls up immediately it strikes the water. In the globule itself, upon immersion, rapid cooling of the outer "skin" takes place, so that strain is set up in the glass, whilst vacuum bubbles form as the interior of the drop cools and contracts. The drop is removed from the water at once (by its tail) and set aside to cool.

When cold the drop can be hammered heavily upon its "head" without effect. It will withstand the heaviest blows and many of these drops will resist the action of a steel glass-cutter or even a diamond. However, if the body of a Rupert's Drop is held tightly in a clenched hand, and the projecting tail is broken sharply away, the whole object fractures, disintegrating into a little pile of powdery glass in the palm of the hand. This glass has no sharpness and will not cut the skin. The disintegration is accompanied by a report, often quite loud, and for this reason the drops are sometimes called "crackers."

References to them in literature are to be found in an epigram from Samuel Butler's "Hudibras" (1663) which reads:

> "Honour is like that glassy bubble
> That finds philosophers such trouble;
> Whose least part cracked, the whole doth fly,
> And wits are cracked to find out why!"

Samuel Pepys, in an entry in his Diary under the date January 13th, 1662, says:

> "Mr. Peter did show us the experiment of the chymicall glasses, which break all to dust by breaking off a little small end; which is a great mystery to me."

The disintegration of the drop is really due to the sudden release of the internal strain which exists in the globule. It has been observed that the larger the enclosed vacuum bubble, the louder the report, and the more violent is the reaction upon breakage.

(*Continued on page* 175)

Reprinted by permission from The Pottery Gazette and Glass Trade Review, London, England.

ZINC OXIDE IN GLASS

By NORBERT J. KREIDL*

PART III

The favorable effect of zinc oxide on the quality of fluorine opal glass is outstanding. Not only is the opacity increased by zinc oxide if the amount of fluorine introduced is constant, but the whiteness and lustre of the glass is superior to that of a zinc free glass of equal light transmission. Zinc oxide has been used consistently in all grades of opal glassware. At present the tendency prevails to obtain the desirable combination of scattering power, transmittance, and reflectivity by controlled heat treatment rather than by the use of anything but a soda-lime glass as a base glass. The plants operating pots or day tanks for the production of illuminating ware, however, cling to the use of zinc oxide. The diversity of illumination tests to be met and the variety of shapes which would not respond to a standardized heat treatment justify this attitude. Moreover, the zinc borosilicate base glasses exhibit the thermal resistance which is required in this type of ware. The following examples of commercial opal glasses are selected from recipes used in the illuminating glass industry of various countries. (Table XXIV and XXV)

The action of zinc oxide in fluorine opal glasses is more involved than in any of the other cases. The scattering, transmission, and reflection properties of opal glass are determined by number, size, and optical properties of the fluoride crystals precipitated in the parent glass. The zinc oxide exerts various influences on these parameters. We know that the influence of ZnO on the viscosity is eminent and the growth of the opacifying particles depends on viscosity; but we find that the characteristics of the zinc glass are too exceptional to be dependent on this property alone. A glass of equal viscosity should be reproducible by other combinations of constituents. Both number and size of the fluoride crystals depend on their solubility in the base glass which can be strongly modified by the addition of an oxide like zinc oxide. We shall see that the solubility of other opacifiers is also decreased by zinc oxide. Finally, optical properties, solubility and growth of the particles would be changed fundamentally if zinc fluoride was formed in the precipitated phase. As a rule sodium fluoride represents the bulk of the precipitation in a fluorine opal glass; if the Ca^{++} concentration is high, calcium fluoride appears associated with sodium fluoride. The presence of zinc fluoride as a third crystalline type will not be detected easily, but in illuminating ware of high zinc content the unique appearance of the beautifully white glass accompanied by unexpectedly high transmission should be attributed partly to this possibility. Finally the volatility of fluorine may be decreased by zinc due to an influence similar to that of aluminum, although no pertaining investigation of quantitative nature is available. Whatever the detailed mechanism may be, the experience gained with complex glasses of various compositions could be reproduced with relatively simple glasses studied in our laboratory.[58]

*Ceramics Department, Pennsylvania State College.

TABLE XXIV

OLDER OPAL GLASSES

	Bohemian 1905	French	German (Lusatia)
Sand	100	100	100
Soda	15.75	16	18
Potash*	15.75	8	4.7
Al. Hydr.	5.25	10	10.7
Fluorspar	21.	20	....
Zinc oxide	**5.25**	**8**	**9.4**
Feldspar	....	10	....
Cryolite	....	....	17.4
Lime	....	....	16
Red lead	....	....	5.35

*Bohemian potash usually contains only 75% K_2CO_3, the rest being Na_2CO_3, KCl, NaCl, K_2SO_4 No_2SO_4 and phosphates

In a series of glasses derived from the composition $Na_2O.O.2Al_2O_3.2.6\ SiO_2$, a part of the Na_2O was replaced by MgO, CaO, ZnO, SrO, BaO, PbO, in equivalent amounts. The formula of these glasses can be represented by:

$8Na_2O\ .\ 2RO\ O.\ 2Al_2O_3.2.6\ SiO_2$ (RO = MgO, CaO, ZnO, SrO, BaO, PbO-

TABLE XXV

Good Practice in (Bohemian) Pots and (American) Day Tanks

	Very[48] Translucent but perfect scattering	Inwald[48] Prague Czechoslovakia	For casing[48] Translucent, perfect scattering in thin layers	Reich[48] Krasno Czechoslovakia	Earlier American Day Tank Type
Sand	100	100	100	100	100
Soda	19.5	19	20.1	....	10-15
Potash*	7.	?	7.25	24	....
Alumina hydrated	7.7	11	8.	....	....
Feldspar	3.8	17	4	?	0-15
Fluorspar	15.4	17	16.1	12	15-20
Zinc oxide	18.5	16	19.3	24	5-10
Sodium Silicofluoride	....	....	....	....	....
Cryolite	7.7	11	6.4	10	....
Nitrate of Sodium	1.55	....	....	4	3
Red Lead	....	....	....	6	3-10
Borax	1.55	....	3.2	....	30-5
Boric Acid	7.7	6	....	20	....
Arsenic	....	....	....	....	....

*See ‡ TABLE XXIII.

By introducing NaF for Na_2O in steps, the minimum of NaF required to obtain equal opacity was listed in order to characterize the influence of the RO oxides on opacification. .5, .6, .7, .8 moles NaF were introduced to replace .25, .3, .35, .4 moles Na_2O. This gives a field of glasses representable by the formula:

$$\left(.8 - \frac{x}{2}\right) Na.\ x\ NaF.2RO.2Al_2O_3.2.6SiO_2 RO.0.2Al_2O_3 .$$

The minimum NaF content to cause opacity was studied in quenched and reheated samples. Besides lead oxide the zinc oxide exhibits the most favorable influence on opacification, that is cloudiness as well as perfect whiteness appear with the addition of less NaF than in glasses containing other divalent oxides; this is born out to a higher degree in the reheated samples.

If results are compared by arranging the divalent oxides according to their atomic weight (Fig. 11) no systematic order appears. But if they are rearranged by placing the elements belonging to the subgroup on top of the lighter elements of the main group they appear to fit into a series (Fig. 12).

It is necessary to emphasize that the Zn, Mg, Sr, Ba, and Pb— glasses of this series were free of Ca^{++} ions. In this respect they differ from the commercial opal glasses, where nearly always a large part of the fluorine is introduced as fluorspar, CaF_2. It also should be noted that the lead glass of the series is compared on the basis of molecular weight, although commercial glasses of such a lead content would possess the entirely different characteristics of a very soft and sweet glass.

Having this in mind, the possible conclusion that MgO could substitute partly for ZnO, deserved examination under conditions more imitative of actual practice. For this purpose 30 lb. melts were prepared in a closed pot. ZnO, CaO, and MgO were interchanged in a commercial batch,[59] with the total CaF_2 content constant throughout the series. This mode of procedure caused all the glasses to contain an appreciable concentration of calcium. In this series the zinc glass was of excellent quality in every respect; the CaO glass was more transparent; and, in contrast to the laboratory series, the MgO glass was very poor in opacity. A glass containing MgO and CaO in the ratio as introduced by dolomitic lime, again besides the constant CaF_2 content, was of intermediate opacity.

Since the Sr- and Ba- glasses are much less opaque there appears to be no substitute for zinc oxide in opal glass in the true sense, that is excluding a special heat treatment or the use of more fluorides, under plant conditions.

As a severe limitation for a more thorough discussion of these more or less empirical results, it should be noted that the remaining fluorine in none of these experimental glasses has been analyzed; the effect of zinc oxide consequently, could not be separated from its possible influence on the volatility of fluorine from the batch.

(13) The Influence of ZnO on Other Opacifiers

The enamel frits do not represent a subject of this paper. The student of the complex nature of the efficiency of zinc oxide in the preparation of a high grade

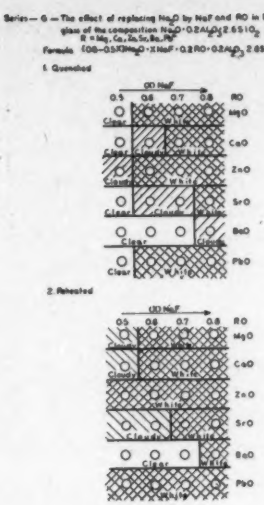


Figure 11

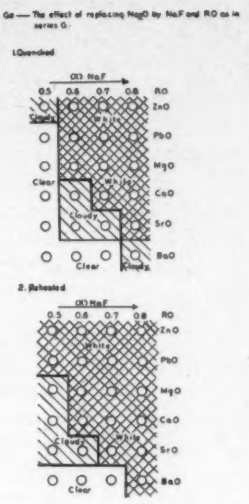


Figure 12

fluorine opal glass, however, cannot fail to be thrilled by a certain parallelism of the action of zinc oxide in opal glasses and enamel frits. This action is the more striking because the enamel opacifiers affected by zinc oxide are not at all subject to volatility; and also because the viscosity of enamels is doubtless within close limits in compositions acceptable to the practice. Consequently, the action of zinc oxide on the opacification caused by zirconia and titanium oxide is restricted to its influence on the crystalline phase formed and the solubility of this phase in the base frit.

In determining the nature of the opacifying crystals as well as in altering the nature of the frit as a solvent for the crystalline ZrO_2 and TiO_2 the addition of zinc oxide has more relation to alumina than to any of the divalent constituents of a frit. This may be due to the possibility of zinc entering into the structure proper of the vitreous phase.[17]

The decrease of the solubility of zirconium oxide in a sodium borate glass representing a simplified enamel frit has been studied by King and Andrews[60] and by Kinzie and Commons,[61] who rate this effect of zinc oxide on practical enamels and glazes next to that of alumina, in contradistinction to that of other divalent oxides. The fact that zinc oxide was not applied to European wet enamels was, for a long period, a hindrance for the introduction of zirconium compounds as opacifiers in this type of ware. In white opaque glazes zinc oxide favors opacification of glazes of glossy appearance.[62] During the present national emergency, glazes containing lead in the base composition and tin oxide as the opacifier are being replaced by zinc containing glazes opacified with zirconium compounds. Wherever SnO_2 is replaced by ZrO_2, zinc oxide will be asked for as long as it is available. The solubility of TiO_2, which, but for its high solubility, represents another suitable opacifier, is decreased by ZnO in the same way. On this basis Tinsley[63] recently obtained an opaque frit on slow cooling.

Besides the solubility the nature of the crystalline phase precipitating from a frit containing ZrO_2 is influenced by ZnO. The pure oxide ZrO_2, with its high refrac-

tive index is the desirable crystal for high opacification, the zirconiates and zirconosilicates possessing much lower indices. The most effective mode of prevention of the precipitation of alkali and other zirconosilicates from silicate melts is by the presence of alumina. Less alumina, however, is required in the presence of zinc oxide[64] which again acts as if it were in a position closer to that of the structure forming elements (Si, Al) than to that of the fluxing elements (Ca). In this case it appears permissible to say[64] in the terminology of classic chemistry that the more acidic nature of zinc oxide does not permit the formation of zinc zirconosilicates, thus suppressing the probability of phases of lower refractive index. Zirconosilicates form easily, for instance, in the system K_2O, ZrO_2, SiO_2; K_2O being much more basic than zinc oxide.

(14) Crystalline Glazes. Devitrification

In glasses the concentrations of zinc as well as the time during which the product is exposed to devitrification rarely favor the crystallization of zinc silicates. It deserves mentioning, however, that in the so-called crystalline glazes the crystallization of zinc silicates is deliberately promoted for decorative purposes.

The formation of crystals of any kind in the commercial glass depends, among other variables, on how high the working temperature is with respect to the liquidus temperature of the composition used. Liquidus temperature is the designation for the temperature above which no crystals can form; it corresponds to the melting point of a simple chemical compound.

As far as the influence of zinc oxide on the liquidus temperature is concerned the experiments of the research laboratory of the Owens-Illinois Glass Co.[11] are of par-

TABLE XV

Table of Zinc Glasses in order of increasing Zinc content. Where batches are given inste

Glass	Purpose	Table No.	SiO_2	Al_2O_3	B_2O_3	P_2O_5	N
Old Bohemian Opal	Whiteness	..	..	..	..	..	
		24	Sand 100	Al.Hydr. 5.25	..	..	
Fry's Apparatus	Resistivity and Expansion	8	68.6	3.1	8.0	..	
Lamp Bulb Enamel	Minor constituent for complexity	22	19.0	1.0	41.6	..	
Soft Phosphate	Resistivity	17	..	23.0	5.0	40.5	
Barium Crown	Optical	18	58.7	3.0	..	..	
"Compound"	Resistivity and Expansion	15	73.5	3.5	..	..	
Older French Opal	Whiteness	24	..	..	..	..	
			Sand 100	Al.Hydr. 10		Feldspar 10	
Heavy Barium Flint	Optical	18	42.8	..	..	..	
Older U.S. Bulb Part	Special Glass	8	58.5	2.5	..	..	
McBeth Evans Tumbler	Resistivity and Expansion	8	73.0	1.4	3.6	..	
Older German Opal	Whiteness	24	..	..	..	..	
		..	Sand 100	Al.Hydr. 10	..	..	
Jena Glass	Resistivity and Expansion	5	66.4	2.4	4.0	..	
Thermometer	"After Effect"	12	66.5	3.8	0.9	..	
Earlier American	Whiteness	25	..	..	..	..	
Tank Opal Type			Sand 100	Feldspar 15	Borax 30-5	..	
Jena Glass	Resistivity and Expansion	4	67.0	2.0	..	..	
Special Lead Free Machine Drawn Tubing		21	61.5	0.5	8.0	..	
Soft Phosphate	Resistivity	16	..	26.2	6.0	36.6	
French Miner's Lamp	Resistivity and Expansion	7	51.3	6.9	3.9	..	
French Apparatus	Resistivity and Expansion	7	69.4	1.0	4.0	..	
English Apparatus	Resistivity and Expansion	7	63.5	9.5	8.7	..	
Bifocal	Optical	18	38.5	..	6.75	..	
Water Gauge	Resistivity	14	72.0	..	4.0	..	
Engl. Light Ba Flint	Optical	18	49.3	0.2	..	..	
Exp. Selenium Ruby	Color Stabilizing	23	69.9	2.4	..	..	
Am. Barium Flint	Optical	18	64.5	..	..	..	
Heavy Barium Crown (Schott)	Optical	18	32.8	2.5	..	..	
Am. Commercial Selenium Ruby	Color Stabilization	23	66.2	0.4	0.5	Calc.Phosph	
Italian Apparatus Glass	Resistivity and Expansion	7	66.0	6.3	10.5	..	
Jena	Resistivity and Expansion	6	64.7	4.5	10.9	..	
Foreign Selenium Ruby Glasses	Color Stabilization	23					
Bohemian Orange	Color Stabilization	23	Sand 100	..	Borax 20.5	Bone Ash	
Bohemian Grenade		23	Sand 100	..	Borax 23	Bone Ash	
Belgian Ruby	Color Stabilization	23	Sand 100	..	Bor.Ac. 2.3	..	
Exper. Selenium	Color Stabilization	23	53.7	..	0.81	..	
Exper. Selenium Ruby, Soft	Color Stabilization	23	53.7	..	0.81	..	
Abbe's Ba-Glass	Optical	19	54.0	..	..	..	
Foreign Opal	Whiteness	25					
Bohemian	Whiteness	25	Sand 100	Al.Hydr. 11	Borax ..	Boric Ac.	
Bohemian	Weakness and perfect scattering	25	Sand 100	Al.Hydr. 7.7	Borax 1.55	Boric Ac.	
Bohemian	Weakness and perfect scattering	25	Sand 100	Al.Hydr. 8	Borax 3.2	Boric Ac.	
Bohemian	Weakness and perfect scattering	25	Sand 100	Al.Hydr. ..	Borax ..	Boric Ac.	
Zinc Borate	Optical	20	..	12.0	54.6	..	
Thermos Bottle		13	62.4	5.0	11.2	..	
Maes' Zinc Crystal	Appearance	1	56.0	..	7.0	..	
Early Thermometer	After Effect	11	54.0	..	..	..	
Wetherill's Thermometer	Appearance	2	60.0	..	..	..	

**See ‡ TABLE XXIII.

A full line of beakers, flasks and sight glasses for locomotive boilers which G. E. Barton developed, was marketed in this country as early as 1902. This made in the article by G. E. Barton, "A New Glass of Low Solubility," Journal of the American Chemical Society, V. 24, No. 9, pp. 893-895, September, 190

ticular significance. The trend of the influence is exemplified by the comparison of the replacement of silica by zinc and barium oxide.

The more barium oxide replaced by silica the more the liquidus curve of a certain soda lime glass was lowered. The progressive substitution of zinc oxide, however, furnishes a minimum of the liquidus curve at 1% zinc oxide. With further addition of up to 5% zinc oxide the liquidus temperature rises, finally above the level of the original soda lime glass. This addition of 1% zinc oxide is just of the magnitude which had been found advantageous in Fourcault glasses by Muehlig (Section 8 of this paper). Still the nature of most practical zinc oxide glasses described is too complex to exhibit any features exactly following the indicated trend. Increase in complexity of glass composition always decreases the probability of devitrification.

The wide-spread use of crystallized zinc silicates in fluorescent lamps is not a subject of this paper, but adds to the importance of zinc oxide in the glass industry.

(15) Electrical Properties

Not much difference was observed by Gehlhoff and Thomas[12] with respect to the influence of ZnO, B_2O_3, BaO, Fe_2O_3, PbO and MgO on the electrical conductivity. Since zinc oxide increases the chemical resistivity this observation is remarkable; for all the other divalent oxides influence chemical and electrical resistivity more or less in the same way. In this respect, zinc oxide again resembles alumina which greatly increases chemical resistance but is not as desirable a constituent for promoting electrical resistivity of silicate glasses.

The power factor, a property indicative of power loss

(*Continued on page* 187)

TABLE XVI

e given insta... oxide percentage, the approximate ZnO percentage is shown above the batch content.

P_2O_5	Na_2O	K_2O	LiO_2	CaO	MgO	BaO	PbO	ZnO	Other Constituents		
..	..	..	..	..	..	..	..	3.0	..	..	..
..	a Ash 15.75	Potash**15.75	..	Fluorspar 21.0	..	..	..	ZnO 5.25			
..	10.0	1.3	..	..	2.6	..	..	3.6	Sb_2O_5	CaF_2	
..	1.5	3.0	2.8	4.7	..	11.3	..	3.8	1.0	5.6	..
40.5	16.5	11.0	..	..	..	..	..	4.0	..	..	..
..	3.0	10.0	..	..	..	20.0	..	5.0	MnO	As_2O_3	..
..	10.5	..	..	7.0	..	..	..	5.0	0.2	0.3	..
..	....	..	..	..	..	..	..	5.0	..	..	..
Feldspar 1	oda 16	Potash 8	..	Fluorspar 20	..	..	..	ZnO 8	..	..	..
..	0.7	7.5	..	..	..	10.8	32.6	5.1	..	..	..
..	8.4	5.0	..	0.5	0.2	..	..	5.5	Sb_2O_3	..	..
..	10.8	0.3	..	0.7	4.3	..	..	5.6	0.6	..	..
..	....	..	..	..	..	..	..	6.0	..	..	..
..	da Ash 18	Potash 4.7	..	Lime 16.0	..	..	Red Lead 5.35	ZnO 9.4	Cryolite 17.4	..	..
..	15.6	..	..	..	5.2	..	..	6.2	MnO	..	..
..	14.8	..	..	7.2	0.2	..	..	6.2	0.3	..	..
..	.....	..	..	..	..	..	..	3.0—8.0	..	..	..
..	a Ash 10-15	..	..	Fluorspar 15-20	..	..	Red Lead 3-10	ZnO 5-10	Cryolite*10-15	Nitrate 3	..
..	8.0	9.0	..	7.0	..	..	..	7.0	..	F_2	..
..	7.0	11.0	..	1.3	0.7	11.0	..	7.0	..	2.0	..
36.6	..	24.2	..	..	..	..	..	7.0	..	Sb_2O_3	..
..	..	2.7	..	..	..	..	27.5	7.2	..	0.5	..
..	6.5	5.9	..	5.8	..	..	..	7.4	..	..	..
..	10.9	..	..	..	..	..	..	7.5	As_2O_5	..	..
..	..	1.7	..	5.2	..	36.1	0.9	7.9	0.7	..	..
..	10.0	..	..	2.0	4.0	..	..	8.0	As_2O_5	Sb_2O_3	..
..	3.2	9.5	..	0.3	..	27.2	0.7	8.6	0.1	0.8	..
..	12.0	1.4	..	3.2	2.1	..	..	9.0	Selenium 0.6	Cadm. Sulf. 0.6	..
..	..	6.2	..	..	..	10.2	9.7	9.2	As_2O_5	..	..
..	..	..	..	..	..	42.3	..	9.2	0.5	..	..
Calc.Phosph	16.0	3.1	..	..	..	..	..	9.4	BASE GLASS ONLY.		
..	6.0	..	..	1.0	..	..	..	10.0			
..	7.6	0.4	..	..	0.7	..	..	10.9			
..	....	..	..	..	..	..	..	>10.0 and more	..	..	..
Bone Ash	a Ash 18.5	Potash** 12.3	..	Limestone 10.1	..	..	..	ZnO+2.3	Cryol. 1.0	Cadm.Sulf. 1.5	Sel. 0.19 S 0.3
Bone Ash	a Ash 21.0	Potash** 14.0	..	Limestone 11.5	..	..	..	ZnO+4.0	Cryol. 1.0	Cadm.Sulf. 2.0	Sod.Sel.1.5S 0.3
..	a Ash 28.0	Potash** 10.7	..	..	..	Baryta 3	..	ZnO+8.5	BASE GLASS ONLY		
..	..	..	..	..	..	..	..	..	..	Cadm. Sulf. Selen	
..	16.25	16.25	..	..	..	..	..	11.37	..	0.81	0.81
..	..	25.0	..	..	..	10.0	..	11.0	..	..	..
..	....	..	..	..	..	..	..	11.0 and more	..	..	..
Boric Ac.	a Ash 19	Potash** ?	..	Fluorsp. 17	..	..	Red Lead ..	ZnO 16.0	Feldsp. 17	Cryol. 11	Sod. Nitr. ..
Boric Ac.	a Ash 19.5	Potash** 7.0	..	Fluorsp. 15.4	..	..	Red Lead ..	ZnO 18.5	Feldsp. 3.8	Cryol. 7.7	Sod. Nitr. 1.55
Boric Ac.	a Ash 20.1	Potash** 7.25	..	Fluorsp. 16.1	..	..	Red Lead ..	ZnO 19.3	Feldsp. 4.0	Cryol. 6.4	Sod. Nitr. ..
Boric Ac.	a Ash ..	Potash** 24.0	..	Fluorsp. 12.0	..	..	Red Lead 6.0	ZnO 24.0	Feldsp. ?	Cryol. 10.0	Sod. Nitr. 4.0
..	3.0	..	..	..	..	..	18.0	12.0	As_2O_5 0.3	..	..
..	8.2	..	..	..	..	..	..	12.8	..	..	..
..	..	17.0	..	2.0	..	..	4.0	14.0	..	..	..
..	..	16.0	..	..	..	..	..	30.0	As_2O_5	Mangan.	Nickel. Ox.
..	20.0	..	..	..	..	..	..	40.0	0.1	0.1	0.01

1902. This ...ained zinc and certainly influenced the later apparatus glasses developed during World War I. The trade name was "Nonsol." Reference to this glass has been ...tember, 19... ...orey, "The Properties of Glass."

Left. **The main entrance to the plant illustrates the simplicity in design. There are no fancy embellishments. The roof and walls are constructed merely to house process equipment, and the supervisory personnel necessary to the operation.**

◈

Center. **Looking through the door of the main entrance to the plant. Fluorescent fixtures are augmented with natural lighting through the glass block around the door frame. A portion of the lobby is partitioned off in order that the telephone operator may also serve as receptionist. Floors in the lobby are concrete with an asphalt tile topping; ceilings are plaster; walls are tile, and brick.**

◈

Right. **Looking down the East side of the building toward the front gives an idea of the vastness of the plant. The fore part of the structure is one story, the back part two story, and takes advantage of the natural topographical conditions of the site. This made it unnecessary to excavate for basement space gave adequate lighting and ventilation on the lower floor at minimum cost. Military**

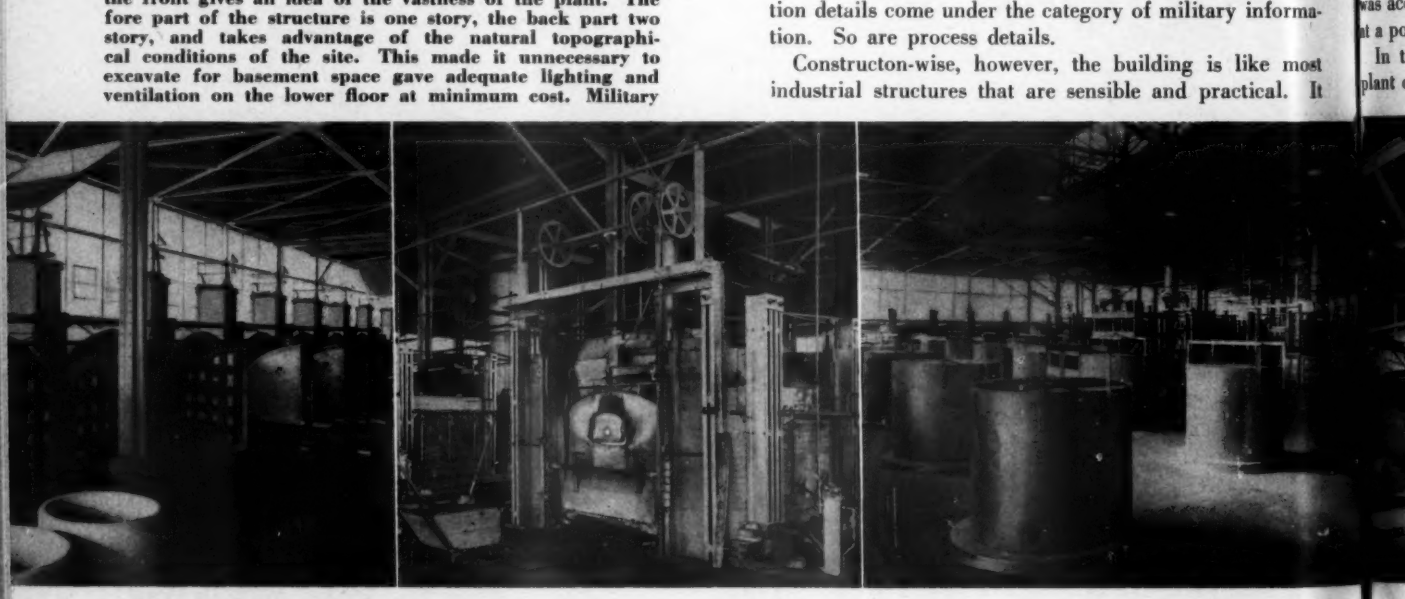
CORNING'S NEW TI

A Model of Efficienc yout

Newest among the glass producing facilities participating in our Nation's war effort is Corning Glass Works' big optical glass plant in Parkersburg, W. Va.

Designed and built by The H. K. Ferguson Company, engineers and builders of Cleveland and New York, the plant is one of the largest of its kind in the world. Devoted entirely to war contracts, the facility's production details come under the category of military information. So are process details.

Constructon-wise, however, the building is like most industrial structures that are sensible and practical. It



authorities requested that the size of the building be withheld.

One of the large heat valves providing adequate ventilation over a section of furnaces is shown atop the structure. The heat valves are adjustable, may be regulated in accordance with weather conditions and interior temperatures.

◈

Left. **A row of pot arches for preheating purposes spans the rear width of the building. The row of continuous sash which forms part of the back wall of the structure has two principal advantages: it allows a large amount of natural light to enter the building, and it helps to ventilate it.**

Center. **One of the melting furnaces. They are almost two stories high, are mounted on the floor below. The pots are placed in the mechanically controlled door with specially devised fork trucks which eliminate the need for a costly conveyor system.**

◈

Right. **The pots of glass are cooled in these kilns after the melting operation. Because of the final precision uses of the glass, greatest care must be exercised in controlling every step in its manufacture.**

EW TICAL PLANT

ficienc yout and Construction

is designed to house a certain process, and its utilitarian value is self-evident on first sight. There are no frills.

High temperatures gave engineers several interesting problems. Mammoth H. H. Robertson Company ventilators were used in the "V" type monitors over the furnaces, and a specially designed "man cooling system" was used to protect workmen tending the furnaces. This was accomplished by installing a duct in the floor located at a point between the workman and the furnace.

In these pictures we present a few highlights of the plant construction and its layout.

Left. **The plant is complete in every detail. The miniature "hospital" is equipped to take care of almost any industrial accident, is provided with a bedroom where patients may rest quietly until permanent arrangements are made if seriously injured. The walls in these rooms, located in the front of the plant, are tile and the lighting is fluorescent. All have fluorescent lighting.**

Right. **Construction on this plant started just before the general ban was placed on the use of steel in manufacturing facilities. This picture was taken under one of the heat valves, and shows the fine steel detail in the trusses. The roof in this particular portion of the plant is corrugated asbestos. In other parts it is either concrete plank or wood deck with bonded composition covering.**

Left. **A general view of the plant showing the furnaces which participate in the second melting operation. The glass is placed on trucks which roll in and out of the furnaces on rails. In the foreground an inspection operation is under way.**

Center. **Final annealing kilns were not yet completed at the time this photo was made. Insulation is lacking around each of the kilns to cover the exposed wire mesh, and electrical control equipment has not yet been connected. Tops of the kilns are raised and lowered from supports on the structural steel trusses. This portion of the plant, near the front of the building, has wood deck roof.**

Right. **One of the grinding rooms. Because of the specialized nature of this operation, this department is partitioned off from the remainder of the plant. The ceiling is plaster, rather than exposed trusses to prevent the collection of dust in the steel members. This section of the building is heated with unit heaters suspended from the ceiling.**

A.C.S. PROGRAM OF PAPERS AND EVENTS

Despite the many difficulties encountered due to war conditions in organizing the 45th Annual Meeting of the American Ceramic Society and even though the meeting period has been limited to four days, April 18 to 21 inclusive, a full program has been completed. Much credit should be given General Secretary Purdy and his staff for their success in organizing the over-all activities of the Society and to Joseph F. Green for his work as Chairman of the Papers and Program Committee of the Glass Division, under such adverse conditions.

In addition to the divisional sessions a highlight of the Meeting will be the "war congress general session" which will be held Monday, April 19th. Morning and afternoon sessions are planned. Among the prominent speakers who will address the Meeting are Amory Houghton, Corning Glass Works, Dr. Francis R. Holden, Industrial Hygiene Foundation of America and Chancellor John G. Bowman, University of Pittsburgh.

The Glass Division Luncheon and Business Meeting will take place Wednesday noon, April 21st. Dr. Alexander Silverman will address the meeting on "A New Proposal for the Glass Industry."

In conjunction with the Glass Division Session there will be a symposium on "Fining and Decolorizing" with emphasis on current necessities for substitutions. These discussions will be led by Dr. W. A. Weyl of Pennsylvania State College and Dr. R. R. Shively of B. F. Drakenfeld. It is interesting to note that fining and decolorizing and the problems involved in substitutions for critical batch materials have been major topics of editorial interest in The Glass Industry during the past months.

Curtailed though it be in number of days, the Meeting will not be devoid of entertainment and other activities such as the Ceramic Camera Club Exhibit.

Chairman of the Entertainment Committee is Ernest M. Hommel, and ladies' entertainment activities will be presided over by Mrs. W. Keith McAfee, assisted by Mrs. Joseph F. Keaney, Mrs. F. C. Flint, Mrs. Ernest Hommel, Mrs. Edward W. Marbaker, Mrs. E. Ward Tillotson and Mrs. H. E. White. Ceramic Camera Club Exhibit is in charge of Victor H. Remington.

Among the interesting diversions is an illustrated lecture scheduled for Sunday night, April 18th, by Dr. Alexander Silverman, "Glass After the War."

This will be followed by a reception, music and refreshments.

Monday evening the Edward Orton, Jr., Fellow Lecture will be given, "Petrology and Silicate Technology," by Norman L. Bowen, Department of Geology, University of Chicago. An informal dance and supper is scheduled for the same evening. Tuesday evening will offer an Evening of Magic presented by Paul Fleming.

The Ladies' Entertainment Committee have planned a trip to the Buhl Planetarium and bridge and luncheon at Boggs and Buhl Store for Monday the 19th. Tuesday forenoon there will be exhibits at the University of Pittsburgh and Carnegie Museum, followed by luncheon and bridge at the University Club. Wednesday afternoon has been reserved for a fashion show and tea at Kaufmann's Department Store.

Quite aside from plans for the Meeting, glassmen should feel at home in Pittsburgh. Although famous as the nation's steel capital, the Pittsburgh area really represents the "glassy state" and those attending undoubtedly will enjoy a most interesting and beneficial experience.

The daily program together with brief summaries of papers to be presented to the Glass Division follow.

GLASS DIVISION PROGRAM

Tuesday A.M.

1. Arkansas Glass Materials.

By Richard J. Anderson: Acting State Geologist, State Capitol, Little Rock, Ark.

2. Method for Estimating Expansibility of Glass at High Temperatures.

By S. R. Scholes and Kurt Mooney: New York State College of Ceramics, Alfred, N. Y.

Molten glass fills to overflowing a measured cavity in a refractory block; on cooling, it leaves a depression whose volume can be measured. After correction for the volume change of the refractory, the cubical expansion of the glass is estimated.

3. Factors Affecting the Degree of Homogeneity of Glass.

By Fay V. Tooley and R. L. Tiede: Research Laboratories, Owens-Corning Fiberglas Corporation, Newark, Ohio.

Methods of glass preparation vary considerably and the degree of homogeneity achieved is a reflection of the complete past history of preparation of the glass. The present study relates to the homogenizing rate of glass under controlled conditions.

4. Fluor Crown Glasses—Effect of Chemical Composition on Optical Properties.

By Murray Scott: Bausch & Lomb Optical Company, Rochester, N. Y.

5. Surface Layer of Sheet Glass.

By F. L. Bishop, Jr.: American Window Glass Company, Pittsburgh, Pa.

This research is an attempt to obtain some evidence of the nature of the fire polish on sheet glass. Results of this research were based on three measurements on each sample. The first of these was a careful measurement of the deviations from Fresnel's reflection laws. A second measurement was based on A. H. Pfund's method of determining the apparent Brewsterian angle as compared to that calculated from the index of refraction of the glass. The third measurement was of the true index of refraction by a prism method in which the samples were cut and ground to 60° prisms.

These measurements showed that freshly drawn sheet glass probably has a crystalline layer several molecules thick on the surface. This layer is of high index but is counteracted quickly by water absorption if the glass is dampened slightly or exposed to the atmosphere.

6. Changes of Properties of a Glass Resulting from Changes of Composition.

By Maurice L. Huggins and Kuan-Han Sun: Research Laboratories, Eastman Kodak Company, Rochester, N. Y.

Equations are given for the calculation of changes in density, refractive index, and other optical constants produced by the addition to a base glass having

(*Continued on page* 182)

Frank Clayton Ball

PRESIDENT OF BALL BROTHERS DIES

Frank Clayton Ball, president of Ball Brothers Company of Muncie, Indiana, died on March 19, in his 86th year, at his home on the White River, after a short illness. Ball Brothers Company is the leading manufacturer of Mason jars for home-canning, and is now engaged in war work in a number of departments.

Mr. Ball's death leaves only one brother, Mr. George A. Ball, of the original five who came to Muncie in 1886 to establish a factory for the manufacture of Ball-Mason glass jars. In 1883 when a patent held by John L. Mason expired, the Balls then living in Buffalo began making the jars. They moved their factory to Muncie shortly after because of the cheaper fuel of natural gas. The output of their company increased by leaps and bounds, when Frank Ball invented a pressing and blowing machine in 1898 which produced jars of better quality and in greater quantity.

Mr. Ball was born in Greensburg, Ohio, the fifth child of Lucius Stiles and Maria Polly Bingham Ball. There were eight children in the family, two girls and six boys. One brother died in infancy, and three of the other five have died in Muncie during the last twenty-five years. They were Dr. Lucius L. Ball, William C. Ball and Edmund Burke Ball.

With his brother, Edmund Burke Ball, Frank Clayton Ball started the manufacture of fish kits, small tubs for packing salt fish in Buffalo, N. Y., in 1876. After a fire had swept away their first plant they began manufacturing cans to contain oil. Finding that their worst competition came from glass oil cans with metal jackets, they became interested in glass, and built a small glass furnace, adding the manufacture of Mason jars to their small business. The brothers then began looking for a site which would provide a cheaper fuel and reduce their operating costs. Muncie, Indiana, was finally chosen and they moved their factory there.

Since then the fortunes of the Ball family have increased and their manufacturing interests have spread to include railroads, sheet metal works, paper mills and other glass factories.

Frank Ball was president of the Muncie & Western Railroad Company and a director of the Federal Reserve Bank and Borg Warner Corporation of Chicago. He was a member of the Board of Trustees of Ball State Teachers' College, Indiana State Teachers College at Terre Haute and Keuka College in New York. He was well known for his many benefactions especially to hospitals and educational institutions.

Surviving Mr. Frank C. Ball are his wife, a son, Major E. Arthur Ball; three daughters, Mrs. Lucina Owsley, Mrs. Margaret Petty and Mrs. Rosemary Wright Bracken, and his brother, George A. Ball.

DOW CORNING CORPORATION FORMED

The Dow Chemical Company of Midland, Michigan, and the Corning Glass Works of Corning, N. Y., have announced the incorporaton of a new company, the Dow Corning Corporation, to be equally owned by the two parent companies.

The new company is organized for the purpose of entering into the manufacture and sale of silicon resinous materials and is the result of a number of years of research on the part of both companies. Officials stated that the formation of the new company would greatly accelerate the development and production of these newly developed materials.

The company is incorporated in the state of Michigan and will manufacture its products in Midland.

Directors of the new corporation are E. C. Britton, Director of Organic Research, Dow Chemical Company; W. R. Collings, Production Manager, Cellulose Products Division, Dow Chemical Company; W. H. Dow, President, Dow Chemical Company; W. R. Veazey, Director, Dow Chemical Company; Glen W. Cole, President, Corning Glass Works; Amory Houghton, Chairman of the Board, Corning Glass Works; E. W. Ritter, Manager of Manufacturing and Engineering, Corning Glass Works; E. C. Sullivan, Vice-Chairman of the Board and Director of Research, Corning Glass Works.

The officers are Dr. E. C. Sullivan, President; W. R. Collings, Vice President and General Manager; Dr. E. C. Britton, Secretary; C. D. LaFollete, Treasurer.

DOYLE APPOINTED ASSISTANT TO PRESIDENT OF LIBBEY-OWENS-FORD

Henry W. Doyle has been appointed Assistant to the President of the Libbey-Owens-Ford Glass Company, according to an announcement recently made by John D. Biggers, president. He takes the position formerly held by Wendell S. Clough who has entered active service.

Mr. Doyle has been a junior executive in the Owens-Illinois Glass Comapny for more than a year. Before coming to Toledo, he was active in the New York financial world and had been merchandise manager for Lord & Taylor of New York City.

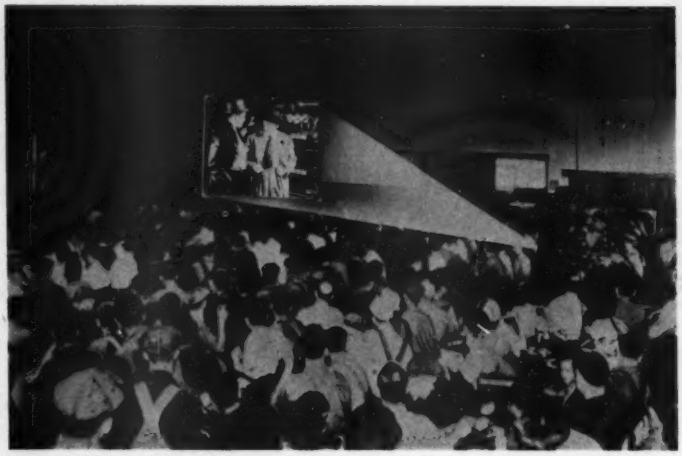
His is a graduate of Princeton University and served in World War I.

FOREMAN TRAINING SOUND SLIDEFILM MADE AVAILABLE TO GLASS INDUSTRY

By LYNE S. METCALFE

Recognizing serious manpower problems produced by War, Carnegie-Illinois Steel Company develop sound slidefilm to augment its foreman supervisory training program. Similarity of problems in glass plants results in offer of film by steel company.

Today, the glass industry, along with other industries faces squarely the problem of training not only many times the number of foremen and supervisors needed during normal operations, but must also give them *special* training to meet war time production obligations because of the growing number of untrained or partly trained workers entering the glass plant.



Says the Training Within Industry branch of the War Man-Power Commission, with regard to this: "It is plain that those responsible for training supervisors must know their task well. Today all plants work under extreme pressure, producing under conditions which are marked by uncertainty about supplies of raw materials, and uncertainty over the available supply of labor."

Certainly these conditions in proportionate degrees, hold good in the glass industry, and whatever can be done to improve the quality of foremanship and supervision is a step in the direction of making the utmost of the supply of labor which is available at the present time.

Most of the larger glass manufacturers have realized this, and have made more or less sustained and systematic efforts to meet the situation. Because, after all, the rate and quality of production depends upon the proper management, "handling," training and control of the individual worker, whose potential values to the production line in turn must depend upon contact management and on the spot direction.

Perhaps in no industry is this more true than in the steel business, which, after all, has personnel problems strikingly similar if not almost identical with glass production. Recently, the Carnegie-Illinois Steel Company, with 130,000 employes, and always progressive in personnel training has augmented its foreman supervisory training program with a series of five sound slidefilms (filmstrips) which have proved to be extremely effectual in raising the standard of supervision in the various Company plants. These slidefilms were devised, planned and produced by the Training Division of the Company for its own private use. However, inasmuch as the subject matter is basic, and the supervisory situations and foremanship principles covered are general, the Company decided, as a contribution to the war production effort to make them available to any employer in the glass industry with foremanship training problems. These films and disc records do not deal specifically with the steel business or any other particular business, and not with products of machinery. They deal with *people*, and the reactions of people to certain types of "handling"—no matter where they work or what they do.

First, let us consider briefly the objectives of The Carnegie Illinois Training Division in arranging this visualized program.

1. The foreman must develop qualified understudies in order to put himself in line for promotion
2. The foreman has a responsibility to the plant safety program
3. The foreman has a responsibility for and an obligation to those who work under him
4. The foreman has a responsibility to listen to suggestions and complaints of his helpers, and do something about it
5. The foreman has a special obligation to the new employee on the job, and to make him or her feel at home at the start

Now, it is obvious that these principles hold good in the glass plants of the country, and in most all other manufacturing organizations as well. They are basic, human principles of conduct which apply to all normal people working in any industry, especially in pressure periods like the present.

Broadly speaking, the five slidefilm subjects are designed to carry down to the foreman and supervisors of the Company certain definite *policies* in employe relations which have been firmly established by the Company's executives in advance.

However, to merely *tell* the foreman of the Company about these principles or to furnish them in printed tracts isn't enough. After all, daily contact with workers calls for tact and skill, and it was felt that an actual pattern as to how these obligations might be met in every practice was needed, and hence the selection of the picture screen to do the job.

Each of these five slidefilms, each with its synchronized voices (on disc record) give the foremen a dramatic picture pattern of situations that arise, and provide a word pattern of what to say and how to say it in each such situation.

If the Company were to set up these broad principles and then leave it to each foreman to carry them out in his own way, trouble might follow. So that the films and records, in the form of *suggestions* to govern employe relations conduct, standardize the method out in the plant.

For those not entirely familiar with the medium, this form of slidefilm is a strip of 35 mm safety motion picture film upon which, each frame projecting an individual picture or scene on the screen in logical order, provides a human touch, and a light story or situation as background. The record on which are voices synchronized with the pictures, provides suggestions as to *what* the foreman shall say to the employee and how he shall say it to get the best results. All "talk" is in terms used every day in steel mill and glass plant, and the actors posing for the pictures are precisely of the type found every day in such surroundings.

Each film and record has a running time of approximately 15 minutes, each is the basis of a single foreman session or meeting. It is customary for the meetings leader to introduce the subject, then run the film and record, after which what has been shown is discussed and the ideas and experiences of those in attendance voiced and noted. Often the film and record is run through a second time. It is not the purpose of the Company to have these films of themselves comprise a foreman training course. Rather, they are to stimulate interest by dramatizing situations common to all foremen, and to rouse discussion among the men attending a regular, planned, supervisory training program.

Attendance is never compulsory. Each supervisor or foreman is invited to attend, and it is interesting to know that the record shows almost one hundred per cent attendance on this basis.

Each subject is presented *objectively*, and there is no "preaching" which means that, in the Company's opinion, the information is gotten across more effectively than if the same information were transmitted by direct lecture or rule-making.

Unquestionably the experience of this great employer of labor of the type commonly empoyed in the glass business, and working in surroundings much like those in the glass works, will be of great value to the glass industry at a time when its own foremanship problems and labor problems are acute and call for the most effectual possible solution. Of course, it has been proved in business and education over the years that pictures will transmit ideas, facts and principles with greater clarity and speed than either verbal lectures or printed text-books Furthermore the picture screen always has a certain allure for everybody, and those who may yawn at a sustained lecture will show keen and undivided interest when the illuminated screen draws attention.

A brief review of the five subjects may help: "Preparing for the Future" (66 individual pictures). This slidefilm shows the foreman why he should develop qualified understudies, and gives pointers and suggestions for selecting and developing them. "Safety for Sale" (73 pictures). This subject dramatizes the foreman's responsibility in the plant safety program, especially in connection with the new worker.

"Fair and Cool" (67 pictures). This subject deals with the foreman's responsibilities to his men, and gives "patterns" for "handling" them. "Big Little Things" (81 pictures). This pictures and describes the foreman's responsibility to listen to his men, their suggestions and complaints, and to do something about it "New Men at Home" (73 pictures). This reveals the foreman's obligation to the *new* employe on the job, with suggestions for making the latter feel at home, and consequently take a pride in his job.

The series of five give the glass plant material for five monthly meetings, upon which the individual plant may elaborate or tie in with its present program as desired.

WATER-REPELLENT COATING DISCOVERED BY GENERAL ELECTRIC

Exposure to the chemical vapors of a new compound called Dri-Film will make cloth, paper, ceramics, glass and many other materials water-repellent, according to Dr. Winton I. Patnode of the General Electric Company's Research Laboratory. One of its most important uses so far is the treatment of ceramic insulators for radio equipment. It is much more effective than wax and its results are permanent.

Dri-Film is a clear liquid composed of various chemcals which vaporize at a temperature below 100 C. Articles are exposed, in a closed cabinet, to the vapors for a few minutes. They are then taken out and, if necessary, exposed to ammonia vapor to neutralize corrosive acids which may collect during the treatment. The film is so thin that its structure cannot be chemically analyzed nor can it be seen under a microscope.

Ceramic forms used in radio communications equipment must have a high electrical resistance. These parts should be free from condensation which forms a film of water and reduces the resistance between conductors. Dr. Patnode developed this new treating material to prevent this condensation from impairing the performance of the equipment.

Another use for the compound is on laboratory glassware, inside the container. This prevents the water surface in measuring cylinders and hydrometers from becoming curved and low in the center caused by the liquid wetting and climbing the walls. After treatment by Dri-Film the water surface is flat and its height can be read more easily.

AMENDMENT TO ANTIMONY ORDER

With the present increased use of antimony as a substitute for arsenic the amendment of March 8 to the General Preference Order M-112 should be of interest to glass men. This amendment states that "not later than the 20th day of the month next preceding the month in which delivery is desired," anyone requiring antimony must file an application for it on form PD-381 and, in addition, must file with the W.P.B. a report on form PD-380, or such other form as may be required.

MULTIFORM GLASS FOR INSULATION DEVELOPED BY CORNING

The development of the process, called Multiform, for making glass for insulation purposes by Corning Glass Works is not only a great forward step in the glass-making industry but also an outstanding answer to the many wartime demands for additional supplies of insulators. Through this process it will be possible to supply insulation in forms that hitherto had been impossible to make in glass in any quantity.

The basis of the Multiform process is in the molding of the article while the batch materials are still cold and then firing the result. Almost any glass composition can be used in the Multiform Glassware, depending on the characteristics required. Laboratory tests have shown that Corning's Glasses No. 7761, 707 and 790 have very low di-electric losses and can be used as insulation at extreme frequencies and will meet the proposed A.S.A. American War Standard on Radio Insulating Materials of Low Dielectric Constant.

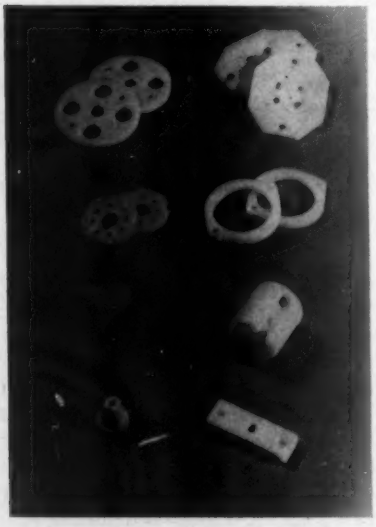
The finished ware is opaque and translucent with a white or ivory tint and does not resemble the familiar transparent glass. Accurate pieces in a wide range of shapes, sizes and special design features are now available. Small insulating beads, several thousand to the pound, and large insulators weighing twenty-five pounds or more can be fashioned by this means. This glassware can also be ground and polished to close tolerances if necessary, and seals to other glasses can be made.

Although insulators made by the Multiform process are less strong mechanically—under comparable conditions—than products of the same composition fabricated by regular glass-making methods, their strength has proved adequate for a very broad group of electrical insulators. Also, their dielectric strengths have slightly lower values than these products, but they are said to be sufficient for all ordinary applications and are much higher than the dielectric strengths of other ceramic products.

Multiform glasses show a water absorption of less than 0.01 per cent (24 hours), and impregnants or added glazes are unnecessary.

Already products made by the Multiform process for insulation include radio coil forms, coil form end plates and flanges, capacitor bushings, tube socket bases, rest bar insulators, antenna strain insulators, filament guides, rectifier rings, switch cups, co-axial line spacers, crystal holders, condenser spacers, mounting blocks, various beads and wafers, and many other electrical and industrial parts. Many more uses for this new glass will be found in the future according to the Corning company.

Here are pictured some of the coil forms and a rectifier ring made of Multiform glassware in the Corning Glass plant.



Left to right: Coil Form End Plates, Tube Socket Base, Wafer Base, Coil Form Flange, Entering Insulator, Antenna Strain Insulator, Capacitor Bushing, Rest Bar Insulator, all Multiform Glass.

INCREASED SHIPMENTS OF IMPORTANT RAW MATERIALS TO COME FROM NORTH AFRICA

Large shipments of strategic raw materials including cobalt ore, manganese, cork, tanbark, red squill and iron ore have been reaching east coast ports of the United States from North Africa via the ships which had brought food, clothing, and other civilian supplies to the people of North Africa. Increased shipments of these materials are expected in the future according to a release by the Office of War Information.

However, it appears that these increased shipments of cobalt will not ease the difficulties of glass manufacturers since the recent amendment to General Preference Order M-39 does not change in any way the original order which prohibits the use of cobalt in glass except as a decolorizer or where pigment is necessary to produce glass for safety or optical purposes. This amendment of March 9, allows persons to sell the cobalt which they may have in stock to the Metals Reserve Company. Also, as of March 9, no one can receive cobalt unless they have applied for it on form PD-581 and form PD-582 as revised on the 20th day of the month next preceding the month in which delivery is required. Any person who has 100 lbs. of contained cobalt the first day of any calendar month must file a report with the W.P.B. on form PD-581 whether or not the person applies for an allocation of cobalt for delivery during the succeeding month.

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During January and February

Compositions

John D. Sullivan and Chester R. Austin of Battelle Institute, Columbus, Ohio, received patents 2,309,070 and 2,309,071 for selenium ruby red glass and black glass compositions. The black glass has a soda-lime-silica base, and contains at least 0.04% selenium and at least 0.1% of a compound of cobalt, nickel or iron, together with a reducing agent. In the process of preparing the black glass from a similar base, and in the presence of selenium, cadmium sulphide and alumina, the batch is melted at 2600-2700°F., withdrawn at 1800 to 2300° and held at 1400 to 2100° for a period sufficient to develop the desired color, before the ware is formed.

U. E. Bowes has assigned to Owens-Corning Fiberglas Corp. patent 2,308,857 covering the following soda-lime-borosilicate glass for fibers:

SiO_2	60 to 75%
$CaO + MgO$	15 to 20%
$Na_2O + K_2O$	8 to 12%
B_2O_3	2 to 7%
R_2O_3	2 to 6%

It is stipulated that the lime is at least equal to the magnesia but shall not exceed it by as much as eight times.

Refractories and Furnaces

Patents 2,310,704, and 2,310,454 concern an oil burner invented by Vergil Mulholland of West Hartford, Conn. (Hartford Empire Co.) and its use in glass making furnaces. As shown by Fig. 1 the burners are arranged in pairs, one above the other so that the flames will impinge together at a predetermined distance from the burners. The burners are constructed so that each imparts a swirling motion to the flame, and so that the direction of swirl from one burner is opposite to that from the other, this resulting in the flame spreading out into a sheet over the glass.

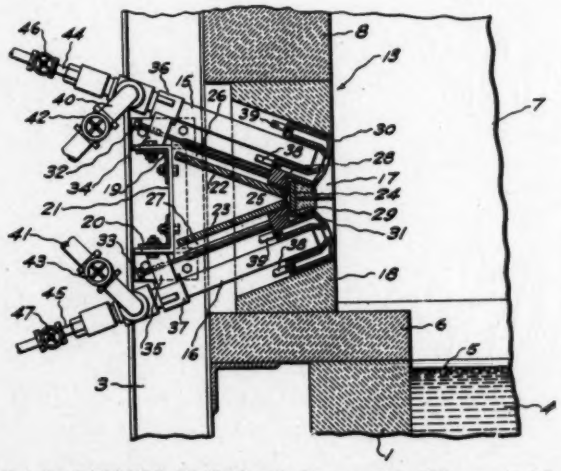


Fig. 1. 2,310,704: Mulholland. Converging oil burners with swirl directed in opposite directions produce a sheet of flame over the hearth.

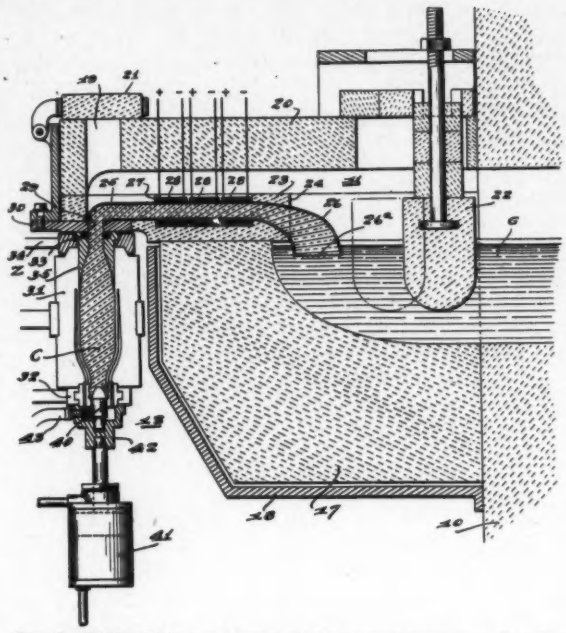


Fig. 2. 2,310,715: Souber. Molds charged by direct drawing with the sheared surplus returning to the forehearth by gravity.

Harold A. Wadman and R. H. Schaefer, also of Hartford-Empire, announce in patent 2,308,473 their discovery that he thermal shock resistance of refractory feeder parts such as tubes and plungers can be greatly improved by so coating them that the outer surface material is under tension when the article is at room temperature. They theorize that the increase in temperature occurring in use releases these stresses without the fracturing which otherwise sometimes occur. Compositions for surfaces and for the body of the ware are given.

Feeding, Forming, and Shaping

Patent 2,310,474 issued to Henry F. Teichmann, Washington, Pa. (Forter-Teichmann Co.) describes a continuous method of manufacturing glass tubing in which the glass is drawn over a water cooled mandrel which extends upward into the nozzle, but which is enlarged at the exterior end.

The group of patents assigned to Owens-Illinois Glass Co. included Clarence Chew's patent 2,307,390 for a glass jug with loop-like handles fastened at the top but free of the bottom. Others were 2,310,715 to L. D. Soubier and 2,310,721 to Joseph W. Watt (Owens-Illinois Pacific Coast Co.) The Soubier patent concerns the apparatus of Fig. 2 for charging a mold by glass drawn upwards form the forehearth by suction applied at the lower or neck end of the mold. Since the top of the mold is higher than the liquid surface of the forehearth, the action of shearing the stream at the mold will cause the excess glass to return by gravity to the hearth. This principle of operation is built into a

rotating machine. The Watt patent involves improvements in a press and blow forming machine for producing wide mouth containers. The improvements center around a so-called secondary finish ring adapted to cooperate with the neck mold and having an overhanging portion which operates to keep the neck of the parison from distorting after removal of the plunger.

A group of four rotary forming machine patents was issued to John R. Bridges of the Lynch Corp., Anderson, Ill., with George B. Langer collaborating in one of the four. Patent 2,307,517 covers a rotary takeout mechanism for forming machines, 2,307,565 a mechanism for opening and closing molds and for stopping the forming machine to avoid damage if a mold fails to open, and patent 2,307,563 concerns means of locking mold sections together so they will not tend to stand slightly open at the joint when pressing or blowing pressure is applied within the mold. Both 2,307,565 and a fourth patent 2,307,564 are intended as improvements on the hollow ware blowing machine described in Bridges' earlier patent 2,049,422 issued in 1936. This fourth patent provides an improved motor driven drive mechanism for the mold carriers, and better means of applying suction to the parison molds to compact the glass charge in the neck end of the mold around the mouth of the forming pin.

Fig. 3 shows one view of the foot forming element of a Libbey Glass Co. machine in which the base of an article of stemware is given its final shaping. This is patent 2,307,425 issued to Harold R. Schutz and Chas. R. Vining. In this continuous rotating machine the inverted articles held by individual rotating chucks first have heat applied to the base to bring it to a working temperature and then are positioned where a pressed carbon backing tool supports the lower surface of the base while a flaring tool 143 is lowered into place to do the shaping.

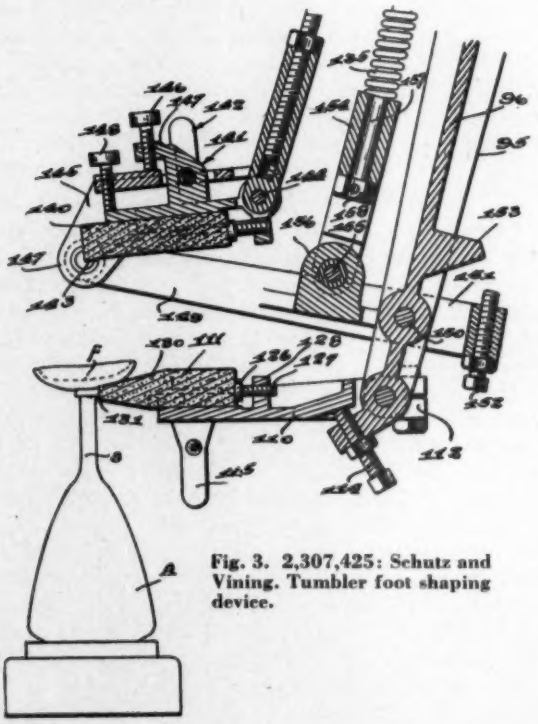


Fig. 3. 2,307,425: Schutz and Vining. Tumbler foot shaping device.

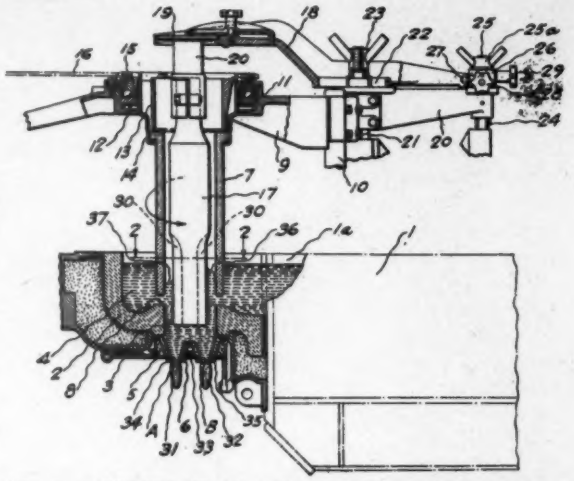


Fig. 4. 2,310,290: Honiss. Varying the speed of rotation of plunger 17 influences the build-up of glass 36 within the feeding tube and allows a balance to be maintained between the flow through two or more apertures.

W. K. Berthold of Rockville, Conn. (Hartford-Empire Co.) received patent 2,309,378 relating to a neck pin and thimble mechanism of a hollow ware forming machine, which allows the simultaneous use of these elements in forming the neck portions of a number of articles. Fig. 4 is from another Hartford-Empire patent (2,310,290 to Wm. T. Honiss) in which provisions are made for feeding glass charges from a plurality of openings around a plunger well in a forehearth. The plunger 17 rotates in a refractory tube 7, and it is found that by controlling its speed the distribution of glass around the plunger may be varied so as to assure the discharge of like gobs from each opening. The illustration indicates how this works by showing the glass at a higher level at the right of the plunger.

Miscellaneous Processes

Three patents comprising a group on cellular or foam glass, assigned to Pittsburgh Plate Glass Co. are 2,310,442 to P. E. Knudsen, 2,310,432 to Elmer H. Haux and 2,310,457 to Wm. Owen. The Knudsen patent involves a slab of cellular glass containing reinforcing rods, and having a permanent outer frame. Haux discloses processes of making blocks whose cellular facing is denser than the block proper. This is accomplished by mixing less of the gassifying agent with this outer layer when the powdered glass charge is fed to the mold prior to sintering. The Owen patent describes a machine for producing cellular sheet material continuously. In one variant of the apparatus, powdered glass and gas forming materials are fed onto the upper surfaces of converging rolls; heat is provided either directly to this layer or through the roll surfaces from within to cause the gas to form and the glass to fuse; the rolls form the cellular sheet which is freed discharged from their under surfaces by scrapers.

Patents 2,309,290 and 2,309,325 are Hartford-Empire patents granted respectively to Wm. E. Aksomitas and

Donald G. Merrill for cooling nozzles to be inserted into containers for tempering them.

Patent 2,311,846 is the latest addition to the Corning Glass Works group of patents issued to J. T. Littleton, H. R. Lillie and Wm. W. Shaver for controlled tempering applicable to top-of-the-stove ware and similar articles. Others have been discussed at considerable length in the April 1941 and August 1942 issues of GLASS INDUSTRY. In this latest patent a certain ratio of compression on the surface layers to tension within is obtained by first giving the heated ware a quick chill followed by a less severe chill.

H. H. Snyder of Pittsburgh (Forter-Teichmann Co.) received patent 2,310,469 for a machine for holding and cutting measured lengths of glass tubing. Patent 2,310,537 to James Morrison of San Francisco describes apparatus for supplying tubing to a bending machine.

Robt. N. Wenzel of Swissvale, Pa., in the Westinghouse patent 2,308,409 discloses an interesting process for impregnating asbestos cloth or other fibrous materials with glass which is finally fused in place. He utilizes the discovery that certain glasses and glass forming materials are soluble in polyhydric alcohols, and prepares glass bearing solutions which are used as impregnants. The alcohol is evaporated leaving the glass within the asbestos cloth where it is given a low temperature fusing to develop a hard film. Solvents for lead oxide and boric acid are ethylene glycol and glycerine, and third components such as silicic acid and lime may also be dissolved in fusible proportions.

To measure the magnitude of strains in rigid articles, Greer Ellis of Cambridge, Mass. (2,310,845, Magnaflux Corp.) coats them with a film which is easily fractured when the article is stressed, and then compares the fracture pattern with standard samples to obtain so-called absolute stress values. He has in mind brittle resins such as highly limed rosins and explains that the coating must be applied under standardized conditions of temperature and humidity.

In the bottle decorating apparatus described in 2,307,404 assigned to Owens-Illinois by C. A. Heyne of Alton, Ill., both the neck and body portions may be simultaneously decorated through screens which are driven from the work-holder at different speeds made necessary by the difference in bottle circumference. Patent 2,311,876 issued to H. F. Scheetz Jr. of Pittsburgh (Fuller Label & Box Co.) describes a method of decoration in which a plastic film containing an opacifying agents is applied to glass, a design in ceramic fluxes is applied to the film, and the composite is fired to fuse the opacifier and design to the glass.

W. G. and G. G. Schneider of East Orange, N. J. (National Union Radio Corp.) received patent 2,312,003 for a machine for making the base portions of electronic tubes. Patent 2,309,612 to Geo. E. Holman of Melrose, Mass. describes a Sylvania Electric Products process for coating the insides of hollow tubes presumably intended for fluorescent lamps. Other miscellaneous patents include 2,309,936 to R. C. David of Leominster, Mass. (Fosgood Corp.) for a lens grinding and polishing machine, and 2,312,176 to S. K. Kotowski of Toledo (Libbey-Owens-Ford) for a glass drilling tool which is essentially self-sharpening.

Plate and Sheet Glass

Patent 2,308,062 issued to John L. Drake of Toledo (Libbey-Owens-Ford) discloses a method of making bent tempered glass in which all horizontal suspension of the sheets is avoided. They are passed through a heating furnace on horizontal rollers, then over a bending surface to which they are made to conform by rolls, and are then received on other rolls which maintain the contour of the new shape and support the sheets while they are air blasted for cooling. Another Libbey-Owens-Ford patent is O. H. Paddock's 2,312,186 for sheet glass washing apparatus.

Fig. 5 presents one view of the cutoff device in patent 2,310,403 for severing sheets from vertically drawn glass. The inventor is Chas. Dice of Mount Vernon, Ohio, and the assignee is the Pittsburgh Plate Glass Co. The sheet 11 moving upwards strikes an electric switch which energizes a solonoid core 18 and causes frames bearing resistance elements R to clamp opposite sides of the glass as shown in the lower dotted lines. The unit being counter-balanced, it is easily lifted upwards by the glass sheet until the resistance elements have rendered the glass severable along the line of engagement. At a predetermined point another switch is operated automatically, de-energizing the solonoid and allowing the resistance supports to swing free of the glass and to return to the lower position. Other Pittsburgh Plate Glass Co. patents were 2,309,331 to M. L. Devol, P. W. Crist and E. J. Hazen for a method and apparatus for severing glass, and 2,310,402 to Brook J. Dennison for a glass insulation unit.

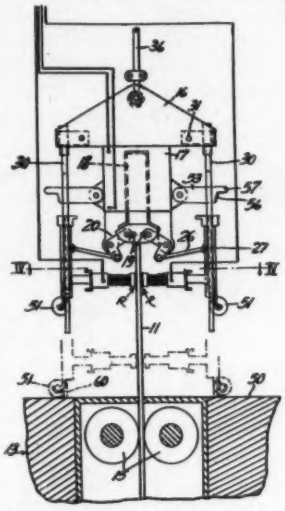


Fig. 5. 2,310,403: Dice. Solonoid-controlled clamps cause resistance elements R. to soften a vertically drawn sheet along a cutting line.

To render tempering furnaces more flexible, Felix Vranken of Jemeppe-sur-Sambre, Belgium, proposes in 2,311,908 to build them in units which can be set together or separated to change the length. By having the walls extendable he also changes their width at will. The top slats through which the glass sheets are suspended are also provided with width adjustment. This patent was seized by the Alien Property Custodian and is available for licensing.

Apparatus for grinding and polishing glass was described in patent 2,309,819 to R. C. Benner of the Carborundum Co.

Glass Wool and Fiber

A. L. Simison's patent 2,311,704 assigned to Owens-Corning Fiberglas Corp. tells how filter discs can be made from glass fibers by arranging a bundle of them with individuals approximately parallel, immersing

(*Continued on page* 174)

BERYLLIUM . .

(*Continued from page* 156)

sponding glass containing MgO, CaO, or other modifier, as indicated by the greater hardness, higher "transformation" and annealing temperatures, lower solubility, and smaller expansion.

TABLE I

Properties of BeO, MgO, CaO, and Al_2O_3 Glasses of Similar Equivalent Compositions

$Na_2O \cdot 3SiO_2 \cdot XMO_{1 \text{ or } 1.5}$		Data After Becker		
MO	$AlO_{1.5}$	BeO	MgO	CaO
Values of X		Linear Coefficient of Expansion X 10^7		
0.25		104.3	104.7	106.1
0.50	95.7	100.9	104.2	107.4
1.00	83.2	100.2		
		Scratch Hardness		
0.25		173.8	168.7	168.1
0.50	174.2	183.2	179.9	176.4
1.00	183.4	193.7		
		Transformation Temperatures, °C.		
0.25		470	435	455
0.50	465	510	450	480
1.00	525	565		
		Annealing Temperatures, °C.		
0.25		522	488	508
0.50	521	559	501	535
1.00	582	614		
		Solubility		
0.25		18.7	37.5	34.97
0.50	9.37	3.25	11.65	11.84
1.00	0.50	0.74		

$Na_2O \cdot MO \cdot XSiO_2$	Data After Lai and Silverman		
MO	BeO	MgO	CaO
Values of X		Hardness	
4.25	6.40	5.93	5.58
4.00	6.44	6.08	5.78
3.75	6.50	5.70	5.58
3.50	6.58	5.88	5.43

BeO-K_2O-SiO_2 System

Glasses in this system were studied by Lai and Silverman[45]. A ternary composition diagram was given, in which an area representing compositions yielding clear glass at about 1400°C. was indicated. The maximum amount of BeO which can be introduced is 13 weight per cent, or about 30 mole per cent. The density and refractive index of 12 glasses with the general composition x $BeO \cdot K_2O \cdot ySiO_2$, in which x had values of 1.25, 1.50, and 1.75 and y, 3.00, 3.25, 3.50, and 3.75, were measured. Increasing the BeO content increases the refractive index and decreases the density.

Polycomponent Systems

Glasses containing small amounts of BeO in complex Polycomponent systems were reported by Pirani and Partridge[61], Meth[54], Ancot[3], and Hanlein[30]. Glasses containing as high as 20 per cent BeO were made by Eisenloeffel[17]. These glasses were made for the purpose of obtaining commercial products having high softening points.

BIBLIOGRAPHY

[1]Akiyama, K.-i., and Sawayama, G., Optical Properties of Calcium Aluminates and Ferrites, Mem. Faculty Sci. Eng. Waseda University Tokio, No. 11, 173-6 (1934); Bull. Waseda Appli. Chem. Soc., **21**, 17-26 (1933). Chem. Abs., **28**, 2236, 5305 (1934).

[3]Ancot, E., Glass, U. S. Patent 1,852,097.

[5]Becker, C. A., Chemical and Physical Researches on Beryllium Glasses, Sprechsaal, **67**, 137, 152, 169, 185, 203, 216, 233, 250 (1934).

[7]Botvinkin, O.K., Beryllium—Glass Transparent to X-rays, Ceram. and Glass, **7**, 25 (1931). Ceram. Abs., **10**, 831 (1931).

[13]Buessem, W. and Eitel, A., Die Struktur des Pentacalcium-trialuminates, Zeit. Krist., **95**, 177 (1936).

[14]Cohn, W. M., Preparation of Fused Zirconia by Means of the Straubel Solar Mirror, Ber. deut. keram. Ges., **12**, 118 (1931).

[15]Cohn. W. M., The Crystal Modifications of Zirconia. A Clear, Fused Zirconia Produced in the Sun Furnace, Trans. Electrochem. Soc., **68**, 65 (1935).

[16]Devers. P. K. (Assignor to Brit. Thomson-Houston Co., Ltd., London) Fused Silica-Beryllia Mixtures, Brit. Pat. 393,899 (1933).

[17]Eisenloeffel, F. E., Glass, German Patent 444,749.

[19]Gaubert, P., C. r. Congr. Soc. Sav. Sci., 1925, Landolt-Börnstein Physikalisch-Chemische Tabellen, 5th Ed., 3rd Supplement, p. 1495.

[21]Gmelins Handbuch der Anorganische Chemie, 8th Ed., No. 26. Beryllium, p. 105, Verlag Chemie G.m.b.H.

[28]Gotteried, C., X-ray Permeability of Beryllium Containing Glasses, Glastech. Ber., **8**, 283 (1930).

[29]Greig, J. W., Immiscibility of Silicate Melts, Am. Jour. Sci., (5), **13**, 1, 133 (1927).

[30]Hägg, G., The Vitreous State, Jour. Chem. Phys., **3**, 42 (1935).

[30]Hanlein, W. (Assignor to General Electric Co.), Glass of High Softening Point, U. S. Patent 2,252,466.

[34]Hovestadt, H. (Translated and Edited by Everett, J. D. and A. E.), *Jena Glass and Its Scientific and Industrial Application*, MacMillan and Co., London, 1902.

[44]Lai, C. F. and Silverman, A., Beryllium Glass, Jour. Am. Ceram. Soc., **11**, 535 (1928).

[45]Lai, C. F. and Silverman, A., Beryllium Glass, II, Potassium-Beryllium Series, Jour. Am. Ceram. Soc., **13**, 393 (1930).

[50]Machatschki, F., The System BeO-SiO_2, Zeit. physik. Chem., **133**, 253 (1928).

[54]Meth. M., Glass, U. S. Patent, 1,789,658.

[58]Morey, G. W. (Assignor to Eastman Kodak Company), Optical Glass, U. S. Patent 2,150,694, March 14, 1939.

[59]Morey, G. W., *Properties of Glass*, Am. Chem. Soc. Monograph No. 77, Reinhold Publishing Corp., New York, N. Y., 1938.

[60]Pauling, L., *Nature of Chemical Bond and Structure of Molecules and Crystals*, 2nd Edition, Cornell University Press, Ithaca, N. Y., 1940.

[61]Pirani, M. and Partridge, J. H. (Assignors to General Electric Co.), U. S. Patent 2,219,331, Brit. Patent 486,444.

[62]Randall, J. T., and Rooksby, H. P., X-Ray Diffraction and the Structure of Glasses, Jour. Soc. Glass Tech., **17**, 287-95 (1933).

[63]Renker, E., Etude dilatometrique de quelques verres ternaires silice-soude-glucine, Compt. rend., **197**, 840 (1933).

[64]Renker, E., Etude dilatometrique de quelques verres ternaires, Bull. Soc. Chem., (5), **2**, 1389 (1935).

[74]Sun, K. H. and Silverman, A., Glassforming Nature of Oxides with Special Reference to Tantala, Titania and Beryllia, Jour. Am. Ceram. Soc., **25**, 97 (1942).

[75]Sun, K. H. and Silverman, A., Can Silicon Take a Six-Fold Coordination in Glass? Jour. Amer. Ceram. Soc., **25**, 101 (1942).

[81]Warren, B. E. and Hill, C. F., The Structure of Vitreous BeF_2, Zeit. Krist., **89**, 481, (1934).

[82]Wartenberg, H.v., Reusch, H. J. and Saran, E., Schmelzpunktsdiagramme hochstfeuerfester Oxide VII. Systeme mit CaO und BeO, Zeit, anorg. allgem. Chem., **230**, 264 (1937).

[86]White, H. E. and Shremp, R. M., Beryllium Oxide, I. Jour. Am. Ceram. Soc., **22**, 185 (1939).

[87]White, H. E., Shremp, R. M., and Sawyer, C. B., Beryllium Oxide Refractories, II, Jour. Am. Ceram. Soc., **23**, 157 (1940).

[90]Zachariasen, W. H., Atomic Arrangement in Glass, Jour. Am. Chem. Soc., **54**, 3841 (1932)

NEW CLOSURES FOR HOME-CANNING RELEASED

Metal closures for glass containers and rubber jar rings will be made available for home-canning purposes by an amendment to Conservation Order M-104 which removed all quota restrictions on the manufacture of certain types of metal lids used to seal jars. A three-piece unit consisting of a tough heat-resistant glass lid, a rubber ring making a snug, sanitary seal at the mouth of the jar, and a metal screw band to hold the lid in place during processing is being manufactured for the first time in quantities by Ball Brothers Company and Hazel-Atlas Glass Company. Even the most inexperienced canner will be able to use this new closure.

The amendment also eased restrictions on the use of metal in milk bottle caps by stating that the same amount of blackplate may be used in the first nine months of 1943 as was used in the corresponding 1941 period.

Research Digest

Practical Interpretations of Glass Technology

During 1942, the Analytical Edition of Industrial and Engineering Chemistry carried several papers on chemical methods that contained subject matter of interest to the glass analyst. Several of these papers on analysis and chemical durability are briefly reviewed in this month's Research Digest.

Direct Determination of Potassium in Silicate Rock

Willard, Liggett and Diehl (Ind. Eng. Chem. Anal. Ed., 14, 3, 234, 1942) describe a method that is applicable to the determination of potassium in feldspar, opal glass, lead barium glass and silicate rocks and which is claimed to be more rapid than the J. Lawrence Smith method and requires less applied time, although the values obtained tend to be slightly higher than those obtained by the classical Smith method.

In brief, the metals in insoluble silicates are completely converted into perchlorates by evaporation of the silicate with hydrofluoric and puchloric acids, followed by a steam-distillation of 140° to 150°C. to remove fluoride as hydrofluosilicic acid. After dehydrating the small amount of silica the solution is evaporated nearly to dryness and the potassium separated twice as puchlorate by extracting the soluble puchlorates with ethyl acetate.

Separation of Lithium from Potassium and Sodium

In the isoamyl alcohol method of separating lithium from potassium and sodium, Caley and Axibrod (Ind. Eng. Chem. Anal. Ed., 14, 3. 242, 1942) found that the use of 2 ethylhexanol instead of isoamyl alcohol yields results equal or better as no solubility corrections are necessary and therefore no attention need be paid to the exact volume of solvent used in the extraction or washing. As it need not be boiled in order to dehydrate the salts properly there is less loss from bumping.

Accurate Determination of Calcium Without Reprecipitation

McComas and Rieman (Ind. Eng. Chem. Anal. Ed., 14, 12, 929, 1942) state that calcium can be precipitated as the oxalate in the presence of Al, Fe, Mg, Mn, P, Na and Ti without interference if controlled conditions and a formate buffer is used. The described method is both rapid and accurate and is recommended for limestone and similar materials but not for sand and other substances which are very low in calcium content.

Use of Phosphate for Separation of Cobalt from Iron

Many of the cobalt materials now available for use in the ceramic industry contain such large amounts of iron that ordinary procedures cannot be used for the estimation of their cobalt content as the iron-aluminum precipitate formed by NH_4OH retains appreciable amounts of cobalt. North and Wells (Ind. Eng. Chem. Anal. Ed., 14, 859, 1942) overcome this difficulty by precipitating the iron as phosphate at a pH of 3.5. The resulting precipitate is easily filterable and practically all of the cobalt passes into the filtrate.

Measurement of Thickness of Fired-on Gold Coatings

Ballard (Ind. Eng. Chem. Anal. Ed., 14, 868, 1942) describes the reagents and procedure used in a jet test method for determining the local thickness of fired gold coatings on ceramic base materials. Only about three minutes time is required for a determination thereby making the method an excellent one for routine control in decorating process where gold banding is done.

Chromatographic Adsorption Analysis

Jones (Jour. Amer. Cer. Soc., Feb. 1943) has described the use of chromatographic adsorption methods in investigating the chemical durability of glass. Strain (Ind. Eng. Chem. Anal. Ed., 14, 245, 1942) has presented an excellent bibliography of the subject which includes technique, apparatus and applications and should be of great interest to those glass technologists interested in studying durability from this approach.

Detecting Basicity in Slightly Soluble Materials

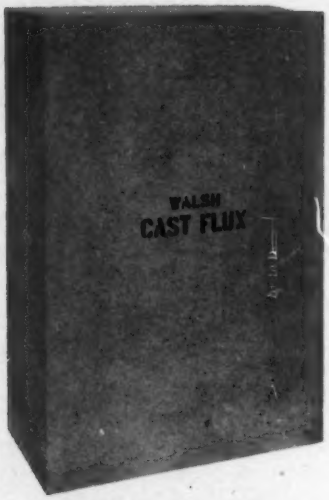
Feigl and DaSilva (Ind. Eng. Chem., Anal. Ed., 14, 316, 1942) have described a procedure for detecting basicity in so-called insoluble materials that may also prove useful in testing the chemical durability (specifically, Alkali release) of glass.

The fundamental step of this new method is to bring a test portion of the solid into contact with a reagent solution which contains all the ingredients necessary to the formation of a colored, slightly soluble inner-complex salt, whose precipitation, however, has just been prevented by an adequate hydrogen ion concentration. In such "equilibrium solutions" the introduction of hydroxyl ions or solid basic materials which react even partially with dilute acids, is followed immediately by the formation of a colored precipitate.

The reagents are made as follows: To 50 ml. of a 4 per cent solution of nickel nitrate or copper nitrate add 100 ml. of 1 per cent alcohol solution of dimethylglyoxime, benzoinoxime, or thionalide, warm briefly on the water bath, and filter. If the reagent is stored in stoppered bottles of neutral glass it can be preserved for one to two weeks. The efficacy of the reagent is not impaired if solid reagent separates on standing. Solutions of nickel dimethylglyoxime that remain clear can be prepared by treating a solution of 2.3 g. of hydrated nickel sulphate in 300 ml. of water with 2.8 g. of dimethylglyoxime in 300 ml. of alcohol and filtering.

Briefly the procedure is as follows: To a few par-

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street
St. Louis Missouri

ticles (circa 0.5 to 1 mg.) of the finely powdered sample on a white porcelain spot plate, add 1 or 2 drops of the "equilibrium solution." Mix by means of a fine glass rod or by blowing through a narrow tube. The vulnerability of the sample to the acid in the "equilibrium solution" determines whether no change is seen, or whether a red (nickel dimethylglyoxime), green (copper benzoinoxime), or dark brown (nickel thionalide) coloration appears at once or after a few minutes. Minute quantities can be tested on a slide, and the development of the color observed under the microscope. Rocks and mineral samples can be scraped with a pen-knife and the resulting powder spot-tested on the main body of the specimen.

Finely powdered window glass and bottle glass reacted positively; a good grade of chemical glass gave a very weak test; and an excellent ampoule glass reacted negatively when tested by this method.

In the case of ampoule glass the authors state that, "nickel thionalide equilibrium solution is a more sensitive test for alkalinity than is phenolphthalein." Although the solution is somewhat less sensitive than the indicator, this may be a real advantage for practical purposes, because the phenolphthalein test is often too delicate when evaluating the quality of a glass with reference to its alkali delivery to water. Ampoule glass of inferior grade can be detected quickly because a little of the powder moistened on a spot plate with 1 to 2 drops of nickel thionalide solution shows red at once. Neutral glass can be tested as to its suitability for ampoule manufacture by comparing the action of a finely powdered sample with that of a standard glass. Glasses of equal quality develop color of the same intensity, if the grain size of the powder is about the same.

OPERATING SUPPLIES REDEFINED BY WPB

Definitions of Maintenance, repair and operating supplies referred to under Priorities Regulation 11 were amended by a recent W.P.B. order of February 20. Many items which have been considered as operating supplies are no longer so regarded by the War Production Board. Among the items excluded from this definition are: fabricated containers, printed matter, stationery, office supplies, fuel or electric power, office equipment, production material, clothing, shoes or other wearing apparel and materials for plant expansion or plant construction.

INVENTIONS . . .

(*Continued from page* 171)

them in oil or other liquids, squeezing out the liquid while compacting the fibers, encasing them in a sheath and finally cutting them into disc-like sections so that the cut surface exposes the fibers in cross-section.

In patent 2,307,117 D. C. Drill of Wabash, Ind. (Amer. Rock Wool Corp.) discloses continuous methods of making batts, blankets and blocks from mineral wool. C. D. Richardson and D. W. Burnett of Alexandria, Ind., assigned to National Gypsum Co. their patent 2,311,870 for melting two distinct fiber forming compositions in separate cupolas and combining the fused material (as in a hearth furnace) before blowing.

GLASS FRIGGERS . . .

(*Continued from page* 157)

Bologna Phials, or Philosopher's Flasks, are perhaps better known among glassworkers as colour proofs. They are primarily made so that the worker can test the colour and quality of the glass. The workman takes a small gathering of glass on his blowpipe, and distends it by blowing. He then elongates the bubble by swinging his pipe (or iron) to and fro, being careful to keep the round end fairly heavy. This action tends to cool the exterior quickly, the interior cooling at a much slower rate. As in the Rupert's Drop, strain is set up in the Phial. The Phial is now cracked off from the iron and is shown in the illustration as a glass tube with the closed end rounded and thickened. The other end has a fairly wide opening. This "frigger" will withstand very heavy blows, but should the surface be scratched ever so little with a diamond, or should small sharp fragments be dropped into the Phial, the whole will break into tiny pieces in a similar manner to that of the Rupert's Drop.

POTASH DELIVERIES RESTRICTED BY WPB

Potash has been placed under the control of the War Production Board by General Preference Order M-291, issued on February 27, 1943. Glass manufacturers must apply for the potash they will need from April 1, 1943 through May 31, 1943 on form PD-600. The amount needed in the period from June 1, 1943 through March 31, 1944, should be applied for through the same office and on the same form on or before May 1, 1943. Potash requirements from April 1, 1944 through May 31, 1944 must be applied for on or before March 1, 1944.

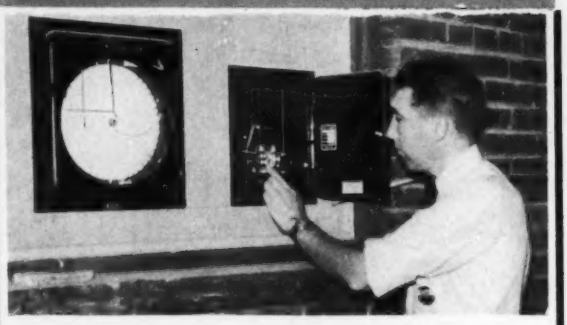
L-O-F PLAN TO ACQUIRE PLASKON CO. AS PLASTIC DIVISION

Libbey-Owens-Ford Glass Company announced their intention to ask their shareholders at the annual meeting in April to approve the acquisition of the remaining outstanding stock of Plaskon Company, Inc. It is planned to operate the Plaskon company as a division of Libbey-Owens-Ford, which marks the entrance of one of the largest flat glass manufacturers into the field of plastics.

Seventy per cent of the stock has been owned by Libbey-Owens-Ford since 1940 which has allowed them to observe the possibilities of this plastic, according to John D. Biggers, president. The large research facilities and abundant capital of the Libbey company will make it possible to extend the uses of Plaskon. No changes are contemplated in the Plaskon Company's personnel.

• Mathieson Alkali Works' Niagara Falls plant has been presented with the Army-Navy Production Award for high achievement in the production of chemicals used in the war effort. The "E" flag was presented on February 26 by Col. Harry A. Kuhn, of the Office of the Chief, Chemical Warfare Service, Washington, D. C., and was accepted by G. W. Dolan, executive vice president of the Mathieson organization.

HOW TRENTON POTTERIES WHIPPED A TOUGH FIRING CONTROL PROBLEM

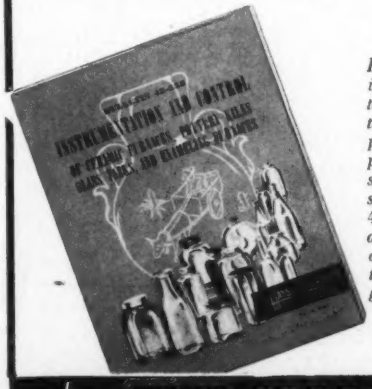


with HAYS Instruments

Many huge shapes go through the tunnel Kilns of Trenton Potteries—shapes of famous Duraclay, only one to a Kiln car, demanding utmost accuracy of firing control to prevent serious losses.

Trenton and Hays engineers collaborated effectively; and Hays Pressure Recorder and Automatic Pressure Control were installed to control pressure near the crown of the Kiln—the critical point. The operator sets the instrument for the correct pressure—and automatically the Control instrument adjusts the dampers to compensate for pressure changes.

Hays Equipment for the Ceramic Industry includes a full line of measuring, indicating and recording instruments, gages and meters, and complete systems of Automatic Combustion Control.



How these precision instruments can save time and money, materials and manpower in ceramic plants of every description, is described in Bulletin 42-552. Glad to send a copy on request—costs nothing, contains data worth a great deal.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	50.00	55.00
Precipitated material		55.00	60.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00–16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)			
Granulated	In bulk, ton	42.50	....
Granulated	In bags, ton	46.00	56.00–61.00
Powdered	In bags, ton	51.00	61.00–66.00
Boric acid (H_3BO_3)			
Granulated	In bulk, ton	96.50	
Granulated	In bags, ton	100.00	111.00–116.00
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.09½–.09¾	.10
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00–13.25	
40 mesh	ton	11.50–13.75	
Granular	ton	11.75–14.00	
Semi-granular	ton	11.00–13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags.			
Fluorspar (CaF_2) domestic, ground, 96–98% (max. SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	34.00	....
In bags	ton	36.40	50.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0900	....
In 5 Ton lots	lb.	....	.0950
Less than 5 Tons	lb.	....	.10
Lime—			
Hydrated ($Ca(OH)_2$–MgO) (in paper sacks)	ton	8.50	9.50
Burnt (CaO–MgO) ground, in bulk	ton	7.50	....
Burnt, ground, in paper sacks	ton	9.50	9.50
Burnt, ground, in 191 lb. gross drums	Per drum	1.70	1.80
Kiln Dried ($CaCO_3$–$MgCO_3$) 10x30 mesh	ton	2.00	....
Kiln Dried ($CaCO_3$–$MgCO_3$) 16x120 mesh	ton	2.00	....
Nepheline Syenite, f. o. b. shipping point	In bulk, ton	12.00	15.00
Potassium carbonate—			
Calcined (K_2CO_3) 96–98%	lb.	.065	.0675
Hydrated 80–85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	21.00–22.00	28.00–30.00
	in bulk	17.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In Paper bags	Per 100 lb.	1.10	
In Burlap bags	Per 100 lb.	1.15	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls. 95% and 97%	Per 100 lb.	....	3.00–3.40
Bulk	Per 100 lb.	1.35	2.50–3.00
200 lb. bags		1.4675	....
100 lb. bags		1.5025	....

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.031–.034	.045
Aluminum oxide (Al_2O_3)		.07	.09
Antimony oxide (Sb_2O_3)	lb.	.15–.16½	.15½–.17½
Arsenic			
Glassmakers	lb.	.04¼	.04¾
Regular refined white	lb.	.04	.04½
Arsenic trioxide (As_2O_3) (dense white) 99%			
In barrels		.04–.04¼	.04½–.04¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite (20% Al_2O_3)	ton	10.00	13.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.06–.06½
Tin Oxide (SnO_2) in bbls.	lb.	....	Open price.
Titanium Oxide (ceramic grade)			
In bags	lb.	.14½	....
In barrels	lb.	.14¾	....
Zinc Oxide (ZnO)			
American process, bags	lb.	.07¼	.07½
White Seal, 150 lb. bbls.	lb.	.09¾	.10
Green Seal, bags	lb.	.09	.09¼
Domestic White Seal, bags	lb.	.09½	.09¾
Red Seal, bags	lb.	.08½	.08¾
Zircon			
Refined Granular (Milled .01–.02c higher)		.03½	.04¼

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40–1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.10–1.15
Cerium hydrate—			
600 lb. barrels	lb.	....	65
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.25–.28
Chromite (99% through 200 mesh)	ton	58.25	64.75
Chromite ore (air floated) Less than 30% Cr_2O_3.	ton	50.00	56.00
Cobalt oxide (Co_2O_3)			
In bbls.	350 lbs. or more, lb.	....	1.84
	Less than 350 lbs., lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.20–.22
Black (CuO)	lb.	....	.19–.22½
Black prepared	lb.	....	Open price
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.06½–.10
Black (Fe_3O_4)	lb.	....	....
Iron Chromate	lb.	....	.035–.05
Lead Chromate ($PbCrO_4$) in bbls.	lb.	....	.16
Lithium Carbonate	lb.	....	1.25
In 5000	lbs.	....	.90
Manganese, Black Oxide African			
In Paper bags	ton	70.00	78.00
In Burlap bags	ton	71.75	79.75
In Casks	ton	74.00	82.00
Neodymium oxalate, 50 lb. drums	lb.	....	4.00
Nickel oxide (Ni_2O_3), black	lb.	....	.35–.40
Nickel monoxide (NiO), green	lb.	....	.34–.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.09½	.09¾–.10
Powdered	lb.	....	.10¼–.10½
Potassium Chromate (K_2CrO_4) 100 lb. kegs.	lb.	....	.27
Powder blue	lb.	....	.21–.25
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) in 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07¼	.07½–.07¾
Sodium chromate (Na_2CrO_7) Anhydrous	lb.	.08½	.08⅞–.09½
Sodium selenite (Na_2SeO_3)	lb.	....	1.50–1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.65
Yellow	lb.	....	1.65
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.40	3.75–4.15
Flowers, in bags	Per 100 lb.	3.05	3.40–3.80
Flour, heavy, in 250 lb. bags	Per 100 lb.	2.95	3.30–3.70
Uranium oxide (UO_2) (black, 96% U_3O_8)		Not presently available	

Polishing Materials

		Carlots	Less Carlots
Pumice Stone,			
American Ground FFF, FF	lb.	.04	.04½
0, 0½, ½, 1, F	lb.	.05	.05½
Putty Powder	lb.	Open price.	
Rotten Stone (Domestic)	lb.	.02¼	.03½
Rouge, Red	lb.	.18	.16
Black	lb.	.15	.18

"Now **there's** a product we can **get**—with **quick delivery**, no **priorities**, no **headaches**, and no need for **'aspirin!'**

THE value of Borax and Boric Acid has long been recognized in the manufacture of different types of glassware. For example, to the ordinary glass container, Borax in the batch imparts brilliance, clarity and improved resistance to mechanical and thermal shock . . . Boric Acid is a primary ingredient in the manufacture of heat resistant glassware.

Borax and Boric Acid is serving in the war effort in many different ways; but fortunately for the glass manufacturing industry, because these products are plentiful, producers of glassware regardless of its degree of essentiality are assured of a dependable supply and uniform quality through Pacific Coast Borax's Twenty-Mule-Team Brand.

20 MULE TEAM BORAX

PACIFIC COAST BORAX COMPANY

DEPARTMENT G • 51 MADISON AVENUE • NEW YORK

CURRENT STATISTICAL POSITION OF GLASS

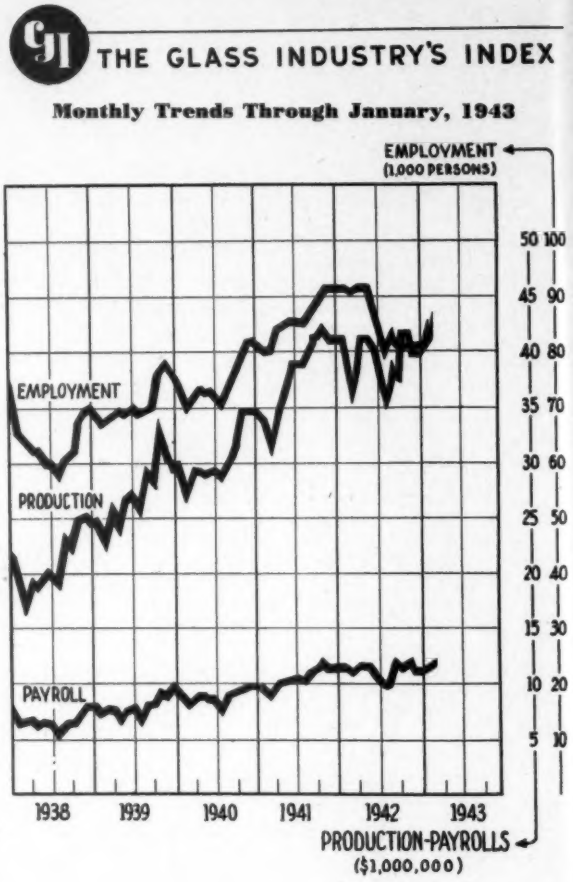
In the Glass Industry's Production Index, a regular monthly feature of this department, certain government figures are used and are essential in the computation of statistics covering the industry's over-all current position from a standpoint of production, employment and payrolls. The necessary government figures are unavailable as this issue goes to press, hence we must publish this month the Current Statistical Position of Glass minus the over-all Production Index.

Starting with the next issue the total volume of the industry's production, the total of miscellaneous glass production, employment and payroll figures will be a month behind all other statistics regularly presented in this department. For example, in the May issue plate and window glass, glass containers, tumbler, table, kitchen and household glassware will be reported for the month of March. The other statistics including the dollar volume of miscellaneous glass products manufactured, the over-all industry's production index in dollars and the figures covering employment and payrolls will be for February.

This change in the publishing date of the above mentioned figures may neeessitate a regrouping of certain breakdowns and replotting of the Production Index chart which has been a regular monthly feature of this department. We believe, however, that these changes will not involve any loss of value in the statistics and they will be presented in a manner insuring freedom from confusion to our readers.

Plate glass production during February totalled 4,775,054 square feet. This showed a decline of 2 per cent from the January figure and was 15 per cent less than last year's comparable total. During the first two months of 1943 plate glass output amounted to 9,685,144 square feet as compared to 14,743,362 square feet last year—a drop of 34 per cent.

Window glass output during February amounted to 1,113,448 boxes, which was a decline of 4 per cent from the January figure and 23 per cent less than February 1942's total. During the first two months of 1943 this production amounted to 2,278,958 boxes or 26 per cent less than 1942's comparable period. The industry operated at 68.6 per cent of capacity during February.



Glass container production during February totalled 6,671,864 gross, according to the Glass Container Association of America. This was 9 per cent less than the January total but exceeded February 1942 by 11 per cent. During the first two months of 1943 glass container output amounted to 14,032,525 gross as compared to 12,719,949 gross in 1942—an increase of 10 per cent.

Shipments of glass containers during February totalled 7,059,727 gross or 14 per cent more than the February 1942 volume. Outstanding gains were reported over last

CURRENT GLASS CONTAINER PRODUCTION

(ALL FIGURES ARE GROSS)

	Production		*Shipments*		*Stocks*	
	Feb. 1943	*Feb. 1942*	*Feb. 1943*	*Feb. 1942*	*Feb. 1943*	*Feb. 1942*
Food Containers (Narrow Neck, Wide Mouth and Pressed Ware)	2,141,810	1,525,470	2,296,892	1,709,836	1,926,042	2,243,922
Pressure and Non-Pressure Ware	446,350	471,325	386,071	408,395	451,682	739,548
Beer Bottles	809,330	575,542	862,253	597,793	286,363	364,316
Liquor Ware	660,565	846,605	731,105	916,560	1,181,902	1,742,558
Medicine and Toilet Ware	1,583,493	1,772,785	1,707,603	1,740,869	2,286,084	3,414,608
General Purpose Ware	590,131	416,969	608.830	428,948	594,795	505,636
Milk Bottles	250,408	225,431	217,001	223,664	360,435	372,480
Fruit and Jelly	176,846	115,952	227,405	96,926	173,345	521,280
All Other	12,931	17,755	22,567	17,568	27,117	45,479
Total Industry	6,671,864	5,967,834	7,059,727	6,140,559	7,287,765	9,949,827

year's corresponding month for domestic fruit jars, 43 per cent; general purpose ware, 38 per cent; wide mouth food bottles and beer bottles, 37 per cent. Cumulative figures for the first two months of 1943 reveal that shipments during this period were 18 per cent greater than last year. Domestic fruit jars increased 172 per cent; narrow neck food containers, 55 per cent; wide mouth food containers and beer bottles, 45 per cent; and general purpose ware, 37 per cent.

Inventories of glass containers at the close of February showed a 26 per cent decrease from last February's level. The only slight increase was in general purpose ware. All others showed a decrease ranging from domestic jelly glasses at 75 per cent to narrow neck food containers with a .56 per cent decrease.

Automatic tumbler production during February totalled 4,189,749 dozens, which was 6 per cent less than January's figure. Shipments during February amounted to 4,210,340 dozens compared to January's figure of 3,762,527 dozens—an increase of 12 per cent. Finished stocks of tumblers at the close of February totalled 7,803,-409 dozens, a slight decrease from January's figure. Cumulative figures for the two months of this year show shipments amounting to 7,972,862 dozens and production totalling 8,664,930 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine made table, kitchen and household glassware during February totalled 3,712,-808 dozens which was 19 per cent higher than last year. During the 12 months ending February 28, 1943, sales of this ware amounted to 40,184,199 dozens or 1 per cent greater than in the previous comparable period.

REVISED PD-1A FORM TO BE SENT TO DISTRICT OFFICES AFTER APRIL 1

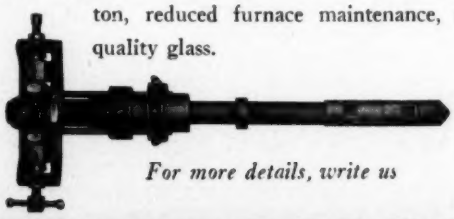
Beginning March 1 all PD-1A forms for securing scarce materials must be sent to the nearest WPB district office. There are 131 W.P.B. district offices in the country. The form PD-1A has been revised on the basis of suggestions from industry representatives and copies of the revised form will be available at W.P.B. field offices after March 1. After April 1 only this form will be accepted for processing.

"MINOR CAPITAL EQUIPMENT" INTERPRETED IN WPB STATEMENT

Monorails, cranes, and similar equipment, costing less than $200 and intended to replace existing equipment or for minor relocation of plant machinery, may be considered "minor capital equipment" and can be purchased with assigned ratings under the provisions of Priorities Regulation No. 11, according to an interpretation of this regulation recently made by the War Production Board. However, those items to be used for plant expansion or costing more than $500 are excluded and will not be considered.

HIGH HEAT AT LOW COST
with TYPE SAL
NATIONAL AIROIL BURNERS

• Flame of high velocity and intense luminosity marks this use of Type SAL National Airoil Oil Burners for firing through the crown of a side-ported glass tank. These burners have required only infrequent cleaning and a minimum of maintenance. Similar applications to tanks of well-known container manufacturers have resulted in low fuel rates per ton, reduced furnace maintenance, and superior quality glass.



For more details, write us

NATIONAL AIROIL BURNER COMPANY, INCORPORATED
1255 East Sedgley Avenue
PHILADELPHIA, PENNA.

We make: Oil Burners, Gas Pilots, Oil Pump and Heater Sets, Explosion Doors, Access Doors, Air Doors, Burner Blocks, Furnace Observation Windows.

NEW EQUIPMENT AND SUPPLIES

"DAG" COLLOIDAL GRAPHITE USES IN GLASS INDUSTRY

The Acheson Colloids Corporation of Michigan have recently released a booklet which describes applications of their "dag" colloidal graphite to the glass industry. According to the folder this graphite prevents molten glass and plastic glass from sticking to the surfaces of turnpins, pincers, cones and other metal glass-working tools thus preventing streaks or washboard surfaces on the finished glass product. This material also improves the lustre of the product and reduces the cleaning and lengthens the life of the mold. Graphite is also used as a lubricant on mold hinges and is invaluable as a parting compound for the screw pegs used to mold threads in glass insulators for the electrical industry.

This graphite is also used effectively in the mold shop as a parting compound for chills, making them readily removable from the casting, on molds and cores in die casting and to lubricate the moving elements of casting machines which operate at high temperatures. Bulletins may be secured on other specific applications.

NEW UNIT ADDED TO SPEED CONTROL EQUIPMENT

The Reeves Reducer-Type Transmission is a new unit in the line of variable speed control equipment which is built by the Reeves Pulley Company of Indiana. This drive has been developed to meet requirements for accurate speed control and speed reduction combined in one compact completely enclosed unit. It consists of the standard Reeves Variable Speed Transmission with a built in Speed Reducer. Far less mounting space is needed to obtain the lower range of speeds which formerly required the use of auxiliary speed reducing equipment.

This new transmission is available in two enclosed designs, horizontal and vertical, which may be mounted in any convenient position.

SHIFTOGRAPH HELPS SOLVE ABSENTEEISM

The Shiftograph designed as a systematic procedure for the rotation of shifts which is a partial answer to the important absenteeism question in war industries has been developed and is now offered to industry by the George S. May Company, business engineers of Chicago, Illinois. Donald M. Nelson, Chairman of the War Production Board, and his associates have approved the consideration of the Shiftograph by companies engaged in war work.

This graph is designed as a perpetual work shift schedule, providing for several different plans of rotation wherein all employees are treated alike, for they share equally in desirable and undesirable work shifts. The user simply turns a dial and can tell at a glance what shifts certain crews will work, the days they work, and their days off. Several thousands of these instruments have been distributed free of charge by the company as its contribution to the war effort.

CATALOGS RECEIVED

Manheim Mfg. & Belting Co., Manheim, Pa.

A comprehensive catalog and instruction manual on the Veelos Adjustable V-Belting has just been published by the Manheim company. It gives the detailed procedure of installing the belt on the drive, and also illustrates a number of typical applications.

Arklay S. Richards Co., Inc., Newton Highlands, Mass. This company has just released a new catalog and engineering data book called "Thermocouples and Their Accessories" to acquaint the pyrometer user with new developments in industrial Thermocouples.

Leeds & Northrup Company, Philadelphia, Pa. A revised edition of their catalog describing the Homo Nitriding method has been issued by Leeds and Northrup. This method is based on the system of forced-circulation.

National Airoil Burner Company, Inc., Philadelphia, Pa. Bulletin No. 65 entitled "Low Air Pressure Oil Burner Type Lap" has just been published. It deals with the Type Lap Oil Burner which uses low pressure air for atomization, for firing process furnaces of all types, with light or heavy fuel oil, under manual or automatic control.

Zenith Electric Company, Chicago, Ill. Latest improvements, applications and prices of the several units manufactured by this company are described in detail in a new bulletin on their automatic control equipment.

Acheson Colloids Corporation, Port Huron, Michigan. This 12-page illustrated bulletin, No. 430-MM, describes the importance of "dag" colloidal graphite to modern industry. It summarizes all the standard colloidal and semi-colloidal dispersions and gives a number of typical applications.

General Electric Company, Schenectady, New York. A simplified guide to the selection and application of commonly used motor controls has been issued by General Electric. The fundamentals and analysis of control and the selection of correct control are described.

Bushings Inc., Berkley, Michigan. An engineering data sheet and folder give the line of insulated bushings and mountings that are now available with rubber, rubber reclaim or synthetics as the insulating medium. The folder illustrates the method of manufacturing the bushings while the data sheet forms a convenient reference list for the designing engineer.

Libbey Glass Company, Toledo, Ohio. The Libbey Glass Company has released an attractive booklet entitled "Can Glass Help You Fill War Contracts Quicker and Better?" giving their mechanical equipment and the types of articles that can be manufactured at their plant. The booklet is designed to acquaint industry with their facilities for solving some problem or manufacturing difficulty which has been caused by critical materials. It gives many of the new uses and describes some of the properties of glass which have been brought to a high degree of development through recent research.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

Kryolith

REG. U.S. PAT. OFF.

NATURAL GREENLAND CRYOLITE

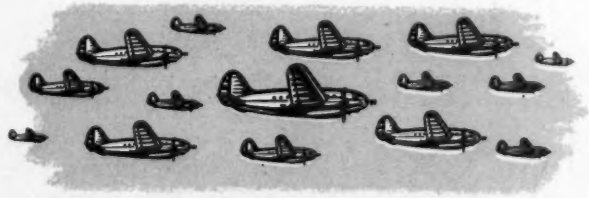
AND THE PROMISE OF THE POSTWAR YEARS

Under the stimulus of wartime needs, the glass, ceramic and enamel industries have made revolutionary advancements. Technicians in these fields have displayed great originality and enterprise in developing new products, perfecting design and discovering new applications.

The gas range illustrated above is one example of what today's activities promise to bring in postwar improvements. The oven has a heat-resisting glass door and top. Its glass-lined interior is brightly lighted. The illuminated instrument panel is translucent glass and the stove's handsome enamel is pure white, chip-proof and good for a lifetime of service.

In the making of these better things in the victory years ahead, Kryolith will play an important part. Kryolith, the *only* refined natural Greenland ore sold in North America, is the fluoride flux and opacifier so widely preferred in the manufacture of better glass and enamel. Its unique advantages are low melting point; strong, long-lasting fluxing action; and the property of dissolving many of the coloring oxides. It is, in addition, an excellent opacifying agent.

For increased production and better quality, insist that the frit you buy is genuine Kryolith. Supplied in 500 lb. barrels and 100 lb. bags. Write for complete information.



KRYOLITH IN THE WAR

Kryolith is serving the nation's war effort as an indispensable flux in the manufacture of metallic aluminum for planes and many types of fighting equipment.

CHEMISTRY IS THE KEYSTONE OF INDUSTRY

PENNSYLVANIA SALT
MANUFACTURING COMPANY
Chemicals

1000 WIDENER BUILDING, PHILADELPHIA

NEW YORK • CHICAGO • ST. LOUIS • PITTSBURGH • WYANDOTTE • TACOMA

FOR SALE: MACHINERY

W. S. Teeple 6 blank, 6 mould, milk bottle machine in good condition. Miller Feeder. Complete except for Miller shears. Now equipped with Bethel shears.

Sommerfeld grinding machine, complete with new 24″ finishing stone.

Circular glazing machine, 3′ track, complete with motor.

A. B. Knight glazing machine, oval track, 16′ between hubs.

Jersey Devil narrow neck machine.

Will accept any reasonable offer on single item or entire lot.

3 10 h.p. Electric Motors, 3 phase.
1 30 h.p. G. E. Induction Motor, 3 phase.
1 40 h.p. Westinghouse type C, 3 phase.
$3.00 per horse power f.o.b. Salt Lake City, Utah.
1 set 16″ x 32″ F. M. Davis Rock Crushing Rolls, $700.
1 set 12″ x 20″ F. M. Davis Rock Crushing Rolls, $400.
Write to
Fred A. Carleson, 535 So. Main St., Salt Lake City, Utah

Two Mixers for Sale: 1-3 Ton Traveling Car Mixer Drum Dimensions 6′ Diameter, 4′ Width; 1 T. L. Smith No. 148 Mixer—Known to the Building Trade as a one Batch Mixer, approximate Drum Dimensions 56″ Hole to Hole, 45″ Diameter. Rolland Glass Company, Clarksburg, W. Va.

HELP WANTED: Position open as factory manager in Pacific Coast bottle plant. Must be under fifty and presently employed in same capacity. Box 60, The Glass Industry, 55 W. 42nd St., New York, N. Y.

Man of Wide Experience in the origin, uses and marketing of non-metallic minerals is now available. Good knowledge of modern glass practice. Draft Status not involved. Box 61, The Glass Industry, 55 W. 42nd Street, New York, N. Y.

GLASS INSPECTION
with the *Polaroid*

Spectacle type polariscope

THE polarizing spectacle, mounted in unit with sensitive tint plate of 565 millimicrons, presents an absolutely uniform field of large aperture, strains showing up in sharply defined and correct colors.

Standard size apertures are 6″ diameter and 12″ diameter; but any special size to meet your requirement can be made. They are all light in weight and a leather case can be furnished where required. The 6″ unit is suggested for either plant inspection uses or—as a portable unit for the trouble shooter or the salesman where a large aperture, compact unit of light weight is desirable.

THE POLARIZING INSTRUMENT CO.
630 Fifth Ave. (Rockefeller Center) **New York City**

A.C.S. PROGRAM . . .

(*Continued from page* 164)

known composition or properties of a known relative weight of a given component, or by the substitution of one component for another. Values are computed and listed for the initial fractional rate of change of refractive index (n_D), when various components are added to (*a*) pure SiO_2, and (*b*) a sodium silicate containing 50% by weight of Na_2O.

7. Glass Properties and the Periodic Table.
By Maurice L. Huggins and Kuan-Han Sun: Research Laboratories, Eastman Kodak Company, Rochester, N. Y.

In previous papers, the authors have deduced and tabulated values of certain constants, characteristic of the component oxides in silicate glasses, which may be used to compute the density and optical properties of these glasses. Graphs are presented in this paper, showing the dependence of these constants on the atomic number of the element (other than oxygen) in the component. The curves obtained enable an estimate, by interpolation and extrapolation, of the values for components for which experimental data are not at present available.

Tuesday P.M.

8. The Vitreous State.
By Maurice L. Huggins and Kuan Han Sun: Research Laboratories, Eastman Kodak Company, Rochester, N. Y.; and Alexander Silverman: Department of Chemistry, University of Pittsburgh, Pittsburgh, Pa.

The difficulty of defining the vitreous state in a rigorous manner, the existence of many borderline cases, and the theoretical requirements which must be met if a substance is to be vitreous are discussed. Certain typical classes of vitreous substances are treated in some detail, with especial regard to relationships between their structures and vitreous properties.

9. Structural Heterogeneity in Glass.
By Aniuta Winter (Mrs.): Research Enterprises, Limited, Control and Inspection Department, Leaside, Ontario, Canada.

Study of the mechanical strains present in a sample of glass does not enable prediction of the future behavior of this glass. There is no simple relation between such strains and the physicochemical state of the glass. In fact, it seems probable that most of these states may be obtained with or without birefringence, depending on the thermal treatment to which the glass was submitted. If the glass is not in the equilibrium condition for the temperature at which it is being used, it will transform spontaneously toward that equilibrium. The birth and evolution of strains depend on these physicochemical unbalances as well as on other characteristics of the glass. Only the study of the physicochemical state can give reliable indications of the behavior of glass in practical use.

10. Transformation Region of Glass.
By Aniuta Winter (Mrs.): Research Enterprises, Limited, Leaside, Ontario, Canada.

Evidence for the existence of a "transformation region" rather than a "transformation point" in the 10^{14} poise range of glasses has been produced by a variety of experiments, both static and dynamic. Refractive index was measured (1) on small specimens quenched in air and (2) directly in the furnace by the single-prism and three-prism methods. Quantitative agreement was obtained, and the method of quenched samples is recommended as the simplest of those tested. Thermal expansion coefficients were also determined on the quenched samples.

11. Molecular Strains and the Extraordinary Thermal Effects in Glasses.

By Arthur Q. Tool: National Bureau of Standards, Washington, D. C.

From measurements made on the delayed or extraordinary volume contractions and expansions in annealing and in "disannealing" glasses, respectively, and also on the accompanying extraordinary heat evolution and absorption, it seems that the quantities of heat evolved and absorbed have the same order of magnitude as the heat equivalents of the work done by and against the enormous "intrinsic pressure" cohesive forces) as glasses contract or expand extraordinarily. In view of these results and other measurements and because of the belief that the structures of glass and many other extremely viscous materials resemble extended and very irregular networks, or cellular-like and random arrangements, of very large molecules or molecular chains and structures, an attempt is made to correlate the extraordinary thermal effects observed in viscous materials with the gradual relaxation of molecular strains that presumably are developed with every temperature change in highly viscous liquids.

12. Method for Computing Approximately the Changes Caused in Glass by Annealing.

By Arthur Q. Tool: National Bureau of Standards, Washington, D. C.

In annealing glass, it is often necessary to change the annealing schedule. Such changes affect the density and refractivity, and the new schedules may or may not result in an adequate reduction of the strain. A method for computing the effects of any change in annealing schedule will be described. Although the results of the computations are only approximate, they will serve as a guide whenever a change in schedule is undertaken. What is more important, they give an insight into the manner in which changes in density and refractivity develop and strains relax.

13. Aging Thermometers.

By Bradford Noyes and Nelson W. Taylor: Department of Ceramics, Pennsylvania State College, State College, Pa.

It is shown that in the long-time aging of thermometers at constant temperature the change in readings of a fixed point, such as the ice point, normally follows an exponential law, $y = a(1 - e^{-mt})$. Methods are described for the evaluation of the total expected change, a, and of the relaxation time, $1/m$, and of the half-life period, $H = 0.693/m$. Examples are given, and calculations are made of the expected change remaining after any aging time, t. It is believed that the exponential law is due primarily to bulb shrinkage under the influence of a single molecular mechanism in the glass. Some examples are presented of anomalous behavior, such as reversals in the direction of change. This phenomenon is shown to be a general one in glass, and an interpretation is given in terms of several molecular processes which operate at one time but with different characteristic rates.

14. Goggle Glass

By E. L. Hettinger: Willson Products, Incorporated, Reading, Pa.

The importance of eye-protective glasses in the performance of the war program is discussed. There is urgent need for uniform specifications throughout the various government agencies. The necessity for the right kind of protection for the specific job is also emphasized.

Wednesday A.M.

15. Devitrification Characteristics of Alkali-Lead Oxide-Dolomite Lime-Silica Glasses.

By J. F. White and W. B. Silverman: General Research Laboratory, Owens-Illinois Glass Company, Toledo, Ohio.

The devitrification characteristics of the field of compositions which included the commercial lime crystal glasses were investigated. Tridymite was found to crystallize from glasses containing as low as 62% of SiO_2. Tridymite, devitrite, diopside, sodium disilicate, and an unidentified compound were found to be primary phases. Potassium oxide (K_2O), in general, lowers the liquidus temperature when it replace Na_2O.

16. Viscosity of Recent Container Glass.

By H. A. Robinson and C. A. Peterson: Armstrong Cork Company, Lancaster, Pa.

Two viscometers which yield highly reproducible results have been constructed for the measurement of the viscosity of glass throughout the entire temperature range encountered in practice. The apparatus is described in detail. Viscosity temperature data are presented for sixteen current container glasses. The chemical analyses of these glasses are also given. It is shown that the data in all cases fit a Fulcher type equation $\text{Log } \eta = -A + \frac{B}{T - T_0}$

17. Experimental Studies of Temperature Gradients in Glasses of Various Colors.

By H. H. Holscher, R. R. Rough, and J. H. Plummer: General Research Laboratory, Owens-Illinois Glass Company, Toledo, Ohio.

A laboratory study was conducted on vertical temperature gradients obtained in a small furnace heated over the glass surface. A surface glass temperature of 2615°F. was held, and the effects of various coloring agents, such as ferrous iron, ferric iron, manganese, and cobalt and chromium oxides, were obtained. These effects are compared with certain commercially colored glasses. The data are important when comparing the maximum melting capacities of commercial furnaces inasmuch as they indicate the over-all heat transmission to the various colored glasses at various depths.

18. Effects of Glass on Neutral Grain Spirits, Gins and Whiskies Stored in Bottles at Room Temperature for Three Years.

By A. Herman and H. L. Shay: Joseph E. Seagram & Sons, Incorporated, Seventh Street Road, Louisville, Ky.

The actual change caused by storing neutral grain spirits, gins and various whiskies in glass bottles supplied by nine different manufacturers and in Pyrex glass at room temperature for three years was determined. The effects of commercial glass on the pH of neutral grain spirits are greater than on gins, blended whiskies, and whisky, respectively. The pH of these products continues to increase proportionately with the time they are stored in commercial glass bottles. Alcohol and gin stored in Pyrex remained constant for one year and increased slightly in pH during the time studied. The pH of blended whiskies and whisky stored in Pyrex glass remained constant.

19. Theoretical Aspects of the Chemical Attack of Glasses by Water.

By Aaron K. Lyle: Hartford-Empire Company, Hartford, Conn.

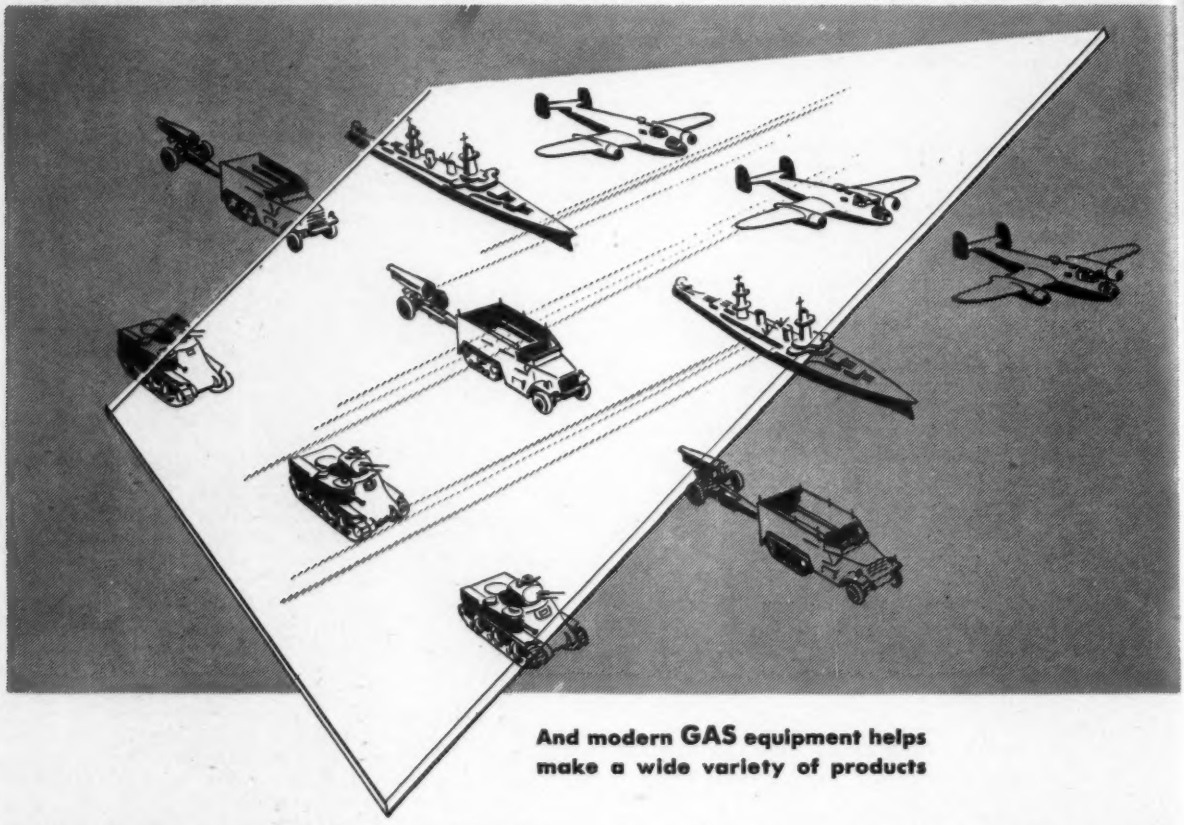
The chemical attack of glasses by water is considered to be a diffusion phenomenon in which the rate of release of soluble matter from the glass is slow compared to its rate of diffusion in the attacking medium. An equation based on the assumed conditions is shown to fit laboratory test data and also to offer some basis for extrapolation of results from accelerated tests to service conditions.

20. Standard Method of Examining and Grading Glass Container Ring Sections.

(*Continued on page* 185)

Versatile

is the role of glass in wartime!



And modern GAS equipment helps make a wide variety of products

Glass plants over the country . . . pushed for faster production for war . . . use Gas in many ways, ranging from the maintenance of huge furnaces at glass-melting heat to processes requiring holding of pin-point flames for special fabrication of glass fibers.

Today specialized types of glass are going into warplanes, tanks, ships, even guns. Other kinds are spun into fibers for insulation of electrical and refrigerating equipment. Much is going into range-finders and other precision instruments.

Glass, therefore, is not only doing a new complex job for war, but is relieving the shortage of metals by providing new civilian products, including containers . . . and in all of this manufacture you find Gas the preferred fuel.

Because of the rapid conversion of processes, it frequently happens that one of your Gas company's skilled fuel utilization engineers can be of direct help. If your own plant is in need of smoother or better-quality production in which fuel usage may have a bearing, why not call your Gas company today and ask for his services?

AMERICAN GAS ASSOCIATION
INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK

THE TREND IS TO GAS!
FOR ALL CERAMIC FIRING

A.C.S. PROGRAM . . .

(*Continued from page* 183)

By W. R. Lester: Maryland Glass Corporation, Baltimore, Md.

The ring-section technique has been studied by the Standard Testing Procedure Committee of the Glass Container Association, and a tentative Standard Method of Examining and Grading Glass Container Ring Sections has been proposed. The scope, method, and frequency of sampling, method of examination, and the methods used for ware quality grading and glass quality grading are described.

21. Determination of Density by a Flotation Method.
By T. C. Vaughan: Hartford-Empire Company, Hartford, Conn.

A procedure for determining density by a flotation method is described. The composition of a liquid is adjusted until its density matches that of the sample. The density of the liquid is then determined using an accurately calibrated standard. The method is highly accurate and is particularly adapted to measuring the density of small chips of glass. No special apparatus is required.

Wednesday P.M.

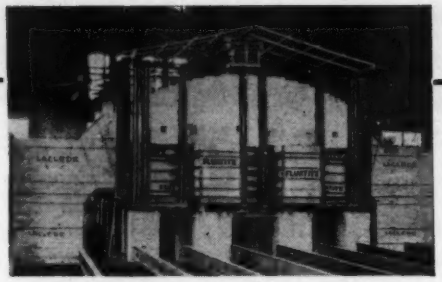
22. Current Problems in the Supply of Fuel Oils and Gas.
By Alfred G. White: Chief Economist, Petroleum Economics Division, U. S. Bureau of Mines, Department of Interior, Washington, D. C.

The decline in tanker movements and the shift to new and more costly overland rail and pipe-line routes created a major problem in fuel-oil supply in the East Coast and Middle West districts in 1942. This situation was further aggravated by the sharp decline in Illinois crude production. A substantial increase in the demand for fuel oils, coupled with a large decline in total gasoline demand, caused a shift in refinery operations, in relative yields, and in refining costs. These factors necessitated complicated adjustments in price, curtailment of fuel-oil consumption by rationing and conversions to other fuels, and abnormally heavy withdrawals from storage. The demand for natural gas gained substantially, owing to the growth of war-industry requirements. The increase in the base load of existing pipe lines reduced the capacity to meet peak-load demands during the winter heating season, particularly in the Appalachian district. Shortages of well-drilling materials restricted exploration and retarded the development of new production of oil as well as natural gas.

23. Raw Materials.
By John R. Hostetter: War Production Board, Washington, D. C.

24. Symposium on "Critical and Substitute Materials"
(A) Fining and Decolorizing.
By Woldemar A. Weyl: Department of Ceramics, Pennsylvania State College, State College, Pa.
(B) Antimony.
By R. R. Shively: B. F. Drakenfeld & Company, Incorporated, Washington, Pa.
Discussion led by
W. F. Curtis: Fostoria Glass Company, Moundsville, W. Va.
H. H. Spengler: Mahoning Glass Works, General Electric Company, Niles, Ohio.
G. E. Reinker: Glass Technology Laboratories, General Electric Company, Cleveland, Ohio.
Rexford Newcomb: Conservation Division, War Production Board, Washington, D. C.

25. American Society for Testing Materials, Committee C-14.



Complete Installations for Bottle Plants
Complete Installations for Window Glass
Complete Installations for Tableware Plants
Glass Melting Tanks and Furnaces
Refractory Materials—All Kinds and Shapes
Blocks—Fire Bricks—Prepared Pot Clay
Automatic Forming Machines
Automatic Feeders
Automatic Glass Tubing Machines
Lehrs-Annealing and Decorating
Installations Built to Suit Conditions Abroad

* * *

IF IT IS FOR THE GLASS INDUSTRY CONSULT US

General Glass Equipment Company
ATLANTIC COUNTY TRUST BUILDING
ATLANTIC CITY, N. J., U.S.A.

BORAX
& BORIC ACID
99½—100% PURE

Stauffer
INDUSTRIAL CHEMICALS

NITRATE OF POTASH
CAUSTIC SODA
SULPHUR

STAUFFER CHEMICAL CO.
420 Lexington Ave., New York, N.Y. 624 California St., San Francisco, Cal.
230 N. Michigan Ave., Chicago, Ill. 555 S. Flower Street, Los Angeles, Cal.

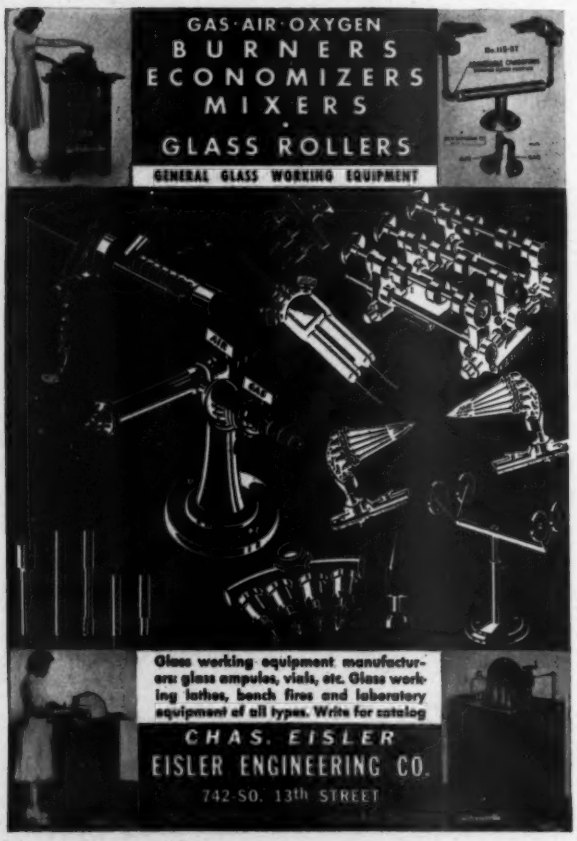
HOMMEL

GLASS COLORS • CHEMICALS

COLORS — Acid and Alkali Resistant • Transparent and Opaque • White and Colored Enamels • Weatherproof Colors • Fluxes . . . . Ices • Liquid Lustre Colors • Burnish Gold.

CHEMICALS — Acids • Ammonium Bifluoride • Antimony Oxide • Arsenic • Barium Carbonate • Bone Ash • Borax • Cadmium Sulphide • Chrome Green Oxide • Cobalt Oxide • Copper Oxide • Cryolite • Feldspar • Fluorspar • Iron Chromate • Iron Oxides • Manganese Dioxide • Potassium Carbonate • Potassium Bichromate • Salt Cake • Selenium • Soda Ash • Sodium Antimonate • Sodium Bichromate • Sodium Nitrate • Sodium Silico Fluoride • Sodium Uranates • Sulphur • Titanium Dioxide • Uranium Oxide • Zirconium Oxide • Zirconium Silicate.

THE O. HOMMEL COMPANY
209 FOURTH AVE., PITTSBURGH, PENNA.
Phone: ATlantic 1195


GAS·AIR·OXYGEN
BURNERS
ECONOMIZERS
MIXERS
GLASS ROLLERS
GENERAL GLASS WORKING EQUIPMENT
Glass working equipment manufacturers: glass ampules, vials, etc. Glass working lathes, bench fires and laboratory equipment of all types. Write for catalog
CHAS. EISLER
EISLER ENGINEERING CO.
742 SO. 13th STREET

PITTSBURGH PLATE DEVELOPS NEW TRANSPARENT RESIN

CR39 is the new transparent resin developed by the Columbia Chemical Division of the Pittsburgh Plate Glass Company which because of its particular properties may find many uses in the war effort. It is understood, however, that full production is several months away.

On heating in the presence of a suitable catalyst, liquid CR39 becomes a hard, insoluble, infusible, clear solid resin resembling methyl methacrylate resins, now used for transparent sheetings on military aircraft and formerly for household items. Less compliant than the methacrylates, it is reported the new resin is also more resistant to chemicals and to heat and, most important, vastly more resistant to abrasion which has been a problem wherever permanent transparency is desired. It is said to compare favorably with other resins in density, strength and shock resistance.

COPPER CHEMICALS ALLOCATED ON QUARTERLY BASIS

Copper chemicals, defined as copper sulfate, copper carbonate, copper oxide, copper nitrate, copper chloride and copper cyanide, will be allocated on a quarterly instead of a monthly basis according to a recent War Production Board release. This is to enable users of these chemicals to plan production over a longer period.

Form PD-600 must be filed by the person seeking authorization to accept delivery early enough so that the copy will be received by his distributor by the first day of the last month of the preceding quarter; or, if he orders from a producer, by the fifth day of that month. The producer or distributor must file application on Form PD-601 by the tenth of the last month preceding the quarter in which delivery is planned.

HAZEL-ATLAS DISCONTINUES TABLEWARE MANUFACTURE

Restrictions on shipping containers and certain raw materials has forced the Hazel-Atlas Glass Company to cease manufacture of all tableware including ordinary tumblers. Some of the facilities formerly used for tableware production has already been diverted to the manufacture of food containers, both packers' ware and home-canning jars. Manufacture of packers' tumblers will continue.

SMALL PLANTS TO RECEIVE AID FROM SWPC

Under the direction of Col. Robert Johnson, its new head, the Smaller War Plants Corporation has begun to try to lessen the difficulties of the smaller companies and assist them in securing war contracts. In this category are the handmade glassware plants who are now being discouraged from manufacturing so-called luxury ware, and may find it advisable to convert to war work.

Representatives are now being placed in the Army and Navy Procurement Control Offices in Washington to see that contracts are allocated as much as possible to the small companies. Loans up to $25,000 are empowered to be made by the local offices to small plants for conversion to war production, and local government procurement officers have been authorized to allow a 15 per cent price differential to smaller firms without War Department approval and with approval 20 to 30 per cent.

ZINC OXIDE . . .

(*Continued from page* 161)

in alternate current systems, is less reduced by zinc oxide than by the other divalent oxides, according to Thurnauer and Badger.[65] In this respect ZnO and MgO act almost in the same way.

From these data no specific action of zinc oxide in electrotechnical glasses can be expected, except because of the fact that chemical resistivity under service conditions is at least as important as the electrical properties themselves.

(16) Foam Glass. Zinc Oxide in Relation to Industrial Hygiene.

It deserves brief mention that zinc oxide was proposed for the use in the manufacture of foam glass in the patents of Long.[66] The principle of the method has been described in a recent issue of this journal.[67]

The glass batches discussed in this paper are summarized in the following table:

In a recent publication on lead free glazes it was suggested that substitution of zinc oxide, just as for lead oxide, should not only be studied from the viewpoint of the present emergency or its possible poisonous action, but also with respect to the effect of the substitute on other ceramic properties.[68]

The problem of the poisonous effect of zinc glazes has been brought up by Seger,[69] but recent work, especially that by Dr. Drinker and coworkers[70] seems to eliminate any objection to zinc containing ceramic ware. There appears to exist no single case of acute indigestion or other poisoning which could be traced back to the use of zinc glazed ceramic ware. Sometimes contrary observations were due to the zinc products having contaminations of arsenic, lead or cadmium. Zinc salts as such and in relatively larger quantities may cause irritations and zinc oxide may cause the so-called "metal fume fever" which is an acute sickness leaving no chronic after effects. According to Drinker more zinc will be ingested when eating a healthy seafood dinner followed by a yeast desert than by a zinc plant worker during a whole day.

Grateful acknowledgement is given to the Pennsylvania State College for contributing to some investigations reported in this paper by a grant from the Central Fund for Research.

[65]The cooperation of Mr. P. A. Corbett, then a Research Fellow of the Pennsylvania Salt Mfg. Co., Philadelphia, Ceramics Department, Pennsylvania State College, is gratefully acknowledged.

[66]The facilities were kindly placed at my disposal by Mr. J. Gillinder, President of Gillinder Bros., Port Jervis, N. Y. The cooperation of Mr. W. Peck is greatly appreciated.

[66]B. W. King and A. I. Andrews "Development of Opacity in ZrO_2 Enamels," Jour. Am. Cer. Soc. **24** (11) 360-367) (1941).

[67]C. J. Kinzie and C. H. Commons, Jr. "Effect of ZrO_2 in Glasses, Glazes, and and Enamels," Journ. Am. Cer. Soc. 17 10) 283-287 (1934).

[68]C. H. Commons, Jr. "Recent Developments in Zirconium Glazes and Effect of Various Materials on Results," Bull. Am. Cer. Soc. 17 (11) 433-434 (1938).

[68]S. G. Tinsley "TiO_2 as an ingredient of Porcelain Enamel Frits,," Cer. Ind. **38** (13) 36-39 (1942).

[68]J. Loeffler, "Use of Zirconium Compounds in Glazes," Ber. D. Keram. Ges. **19** 228-235 (1938).

[68]H. Thurnauer and A. E. Badger, "Dielectric Loss of Glass at High Frequencies," Jour. Am. Cer. Soc. 23 9-12 (1940).

[66]B. Long "Spongelike Glass," U. S. Pat. 1945 052 Jan. 30, 1934; St. Gobain. Brit. P. 533763 Feb. 19, 1941.

[67]E. L. Kreidl "Foam Glass," Glass Ind. **23** (8) 318, (9) 340, section B (1942).

[68]P. M. Corbett and N. J. Kreidl "Development of Leadless Glazes Containing Fluorides," Cer. Ind. **39** (2) 46-50 (1942). The quoted statement was obscured by a typographical error.

[69]H. Hecht and E. Cramer, "The Collected Writings of H. A. Seger," p. 593; Chem. Publ. Co., Easton, Pa. (1902).

[70]C. K. Drinker and L. T. Fairhall, "Zinc in Relation to General and Industrial Hygiene," Public Health Reports **48** (32) 955-961 (1933).

Banner Lime

IS SERVING UNCLE SAM IN GLASS, BUILDING, STEEL, AGRICULTURE AND MAGNESIUM PRODUCTION . . . IF YOU ARE ENGAGED IN ANY OF THESE ACTIVITIES BANNER LIME IS

Essentially yours

NATIONAL MORTAR & SUPPLY COMPANY
PITTSBURGH, PA.

THE SHARP-SCHURTZ COMPANY
CHEMISTS AND CONSULTING ENGINEERS
FOR THE GLASS INDUSTRY
LANCASTER, OHIO U. S. A.

GLASS SPECIALTIES
Transparent Colored Blown Sheet Glass
Solid Pot Opal Blown Sheet Glass
Flashed Opal Blown Sheet Glass
Colonial Antique Colored Glass
Heat-Ray Resisting (Cool Glass)
"TWIN-RAY" — the scientific illuminating glass.

HOUZEX

L. J. HOUZE
CONVEX GLASS CO.
Point Marion, Pennsylvania
New York Office: 110 West 40th St.
Chicago Office: 1597 Merchandise Mart
"IF IT'S MADE OF GLASS, ASK US FIRST"